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Design Engineering

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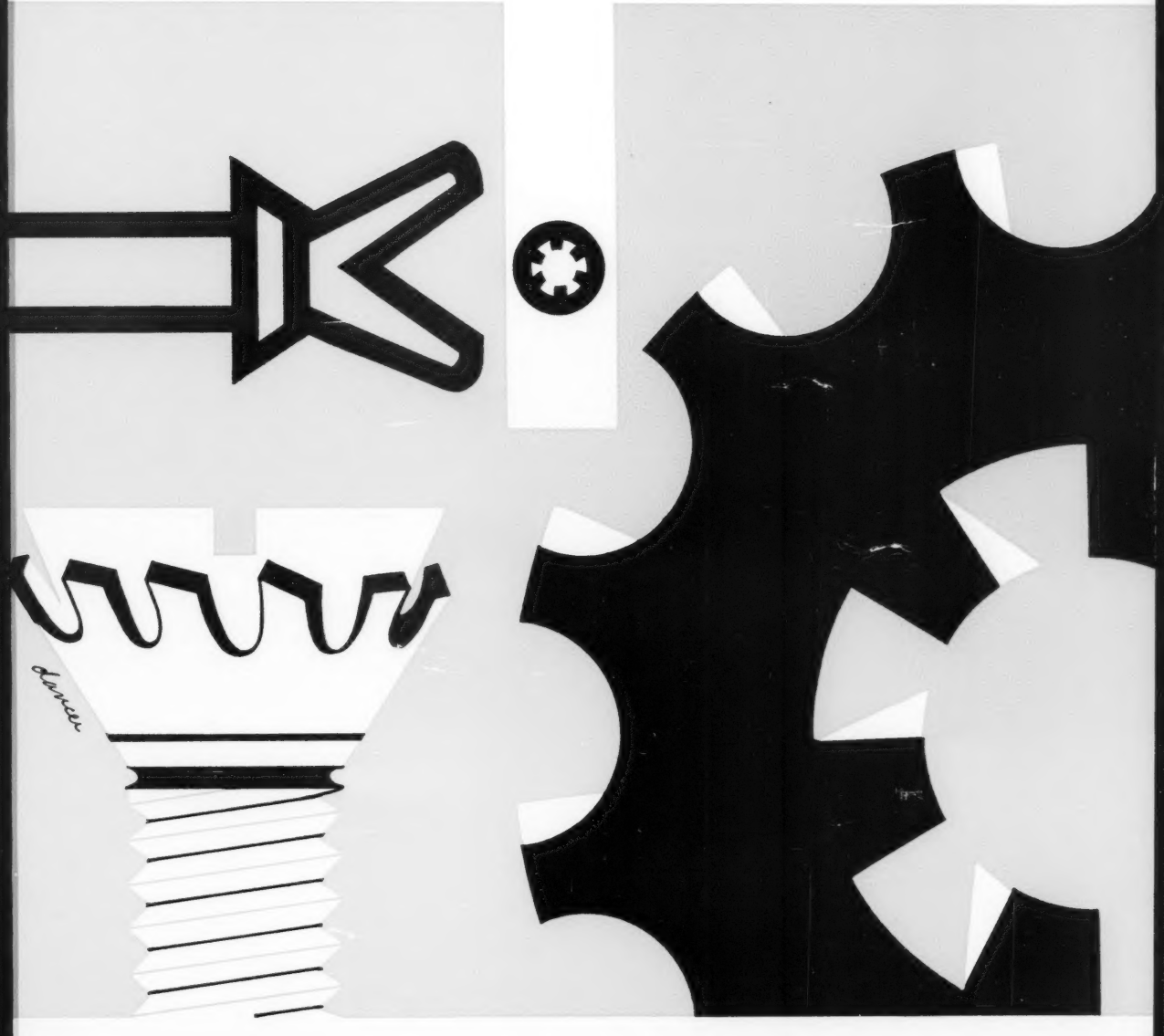


ARE YOU UP TO DATE ON MODERN INDUSTRIAL FASTENERS?

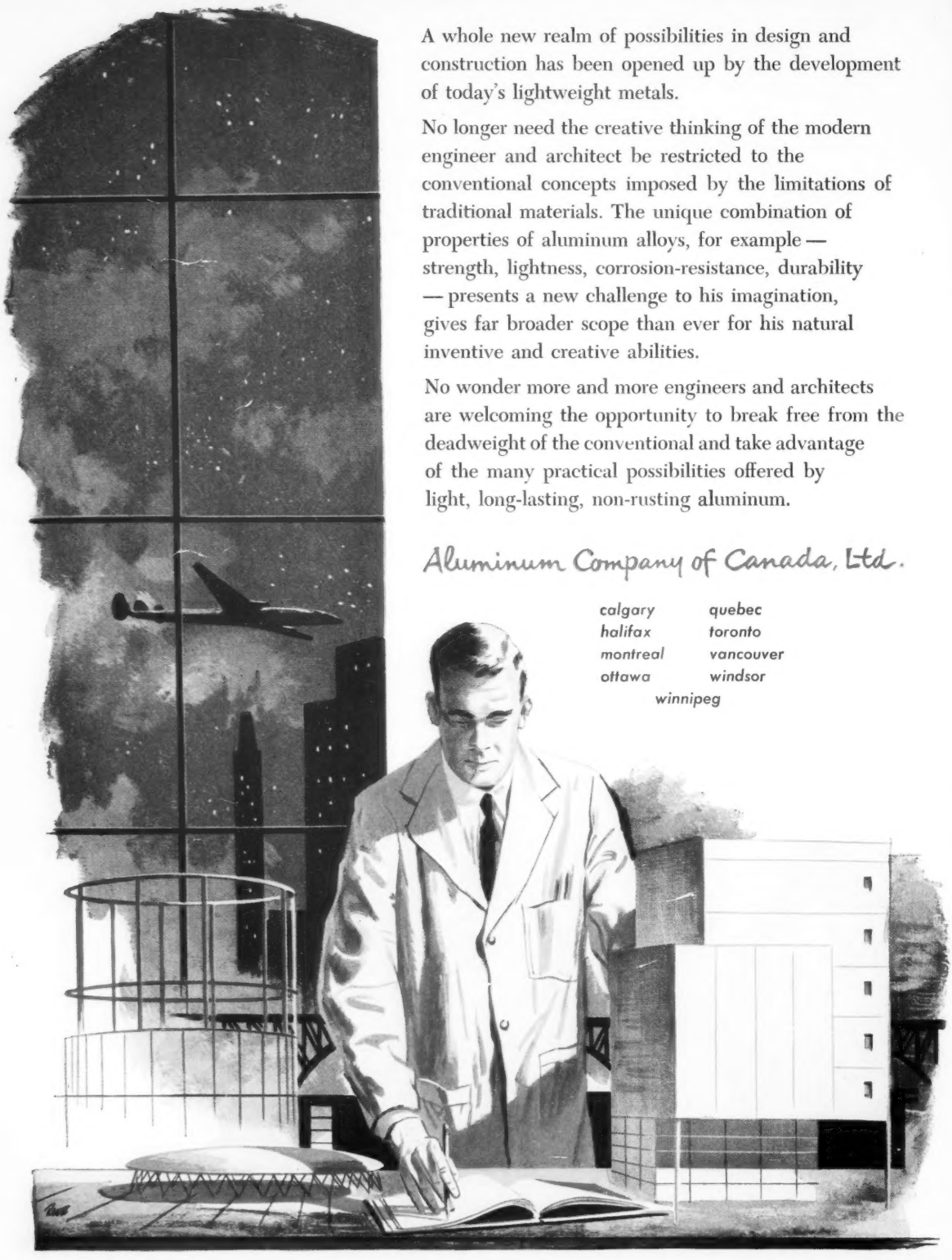
Those versatile devices - thermistors

The high-purity oxygen steels

February 1957

PUBLISHED BY MACLEAN-HUNTER PUBLISHING COMPANY, LIMITED, TORONTO, CANADA

Breaking free from the fetters of convention



A whole new realm of possibilities in design and construction has been opened up by the development of today's lightweight metals.

No longer need the creative thinking of the modern engineer and architect be restricted to the conventional concepts imposed by the limitations of traditional materials. The unique combination of properties of aluminum alloys, for example — strength, lightness, corrosion-resistance, durability — presents a new challenge to his imagination, gives far broader scope than ever for his natural inventive and creative abilities.

No wonder more and more engineers and architects are welcoming the opportunity to break free from the deadweight of the conventional and take advantage of the many practical possibilities offered by light, long-lasting, non-rusting aluminum.

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Design Engineering
ARE YOU UP TO DATE ON MODERN INDUSTRIAL FASTENERS?
Those versatile devices - thermistors
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Design Engineering

VOL. 3 **FEBRUARY 1957** NO. 2

This month's cover

Product of Don Dancer's imagination the cover artwork shows a few industrial fasteners (not a crocodile over mediaeval battlements). Shown, with full artistic liberty taken, are two washers, a sem and a plastic rivet. We leave it to our readers to sort out and identify them.

Design Engineering

MEMBER

CCAB

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In our next issue

Nowadays an awareness of the effects of humidity in a plant is highly important—so many processes depend on it. Our March issue will carry an article on the measurement and control of this water in air. Also on the books are articles on submerged arc welding, tap design and infrared materials plus department pages.

Inside

Ballentine

Forty-six-year-old **Fred Ballentine** has been in the fastener field for 20 years—a good recommendation for any man to write the featured fastener article in this issue. As sales manager of Canada Illinois Tools Ltd. (he's just been appointed general manager. Shakeproof-Fastex), his work has covered fastener analysis surveys in the automotive, electrical, washing machine, refrigerator and agricultural implement fields. Ballentine is an ardent fisherman.

Born in Sarnia, **D. F. Knudsen** is public relations manager for Computing Devices of Canada and the author of the analog computer article in this issue. Knudsen did a 4½-year stint with the RCAF from 1941-45, coming out as a Flying Officer. From the RCAF he went to the University of Toronto, graduating with a BASc in electrical engineering in '49 and then joined the Bell Telephone Co. From 1951 to 1956 he was the editor of Electrical News.

Knudsen

Goodyear

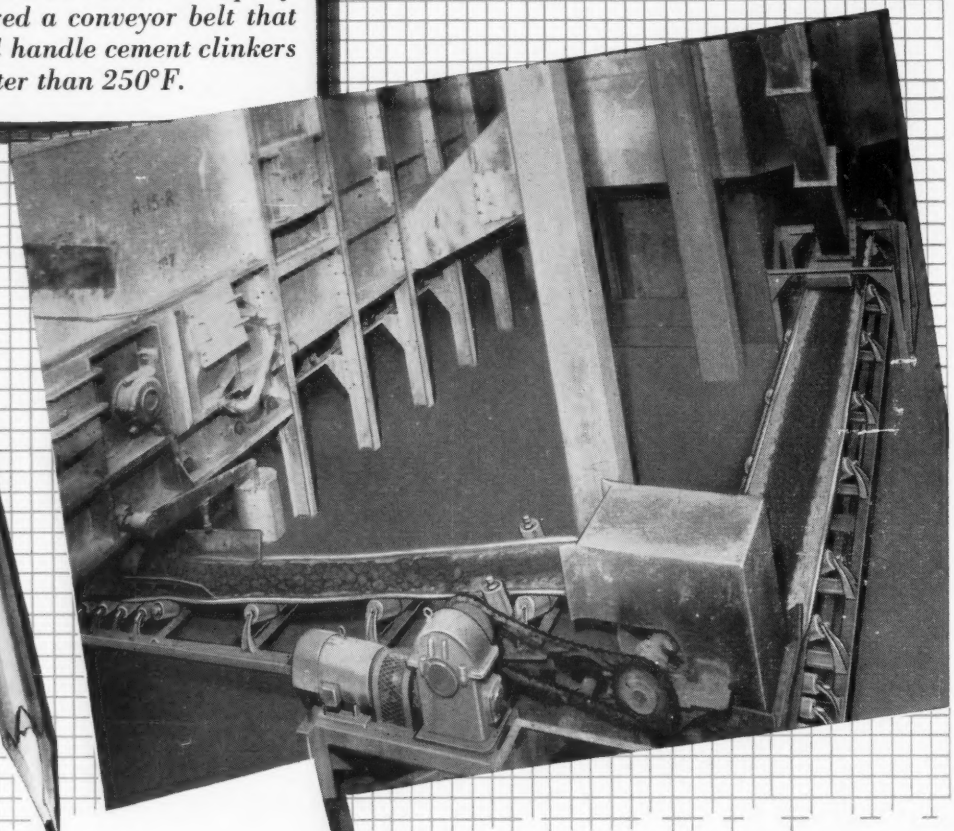
Robert S. Goodyear is president of Fenwal Electronics Inc., Mass. The firm is a specialist in the manufacture of precision thermistors and sensing elements incorporating thermistors. An honor graduate from Harvard University in 1936, Goodyear holds a BS degree in physics and is the author of several technical papers in the electronics field. He was formerly vice-president and chief engineer of Victory Engineering Corp. and was with Western Electric before that.

Irving H. Jenks (author of our article on anodizing aluminum) is a graduate with a BA in English and chemistry from Mt. Allison University. He received a BSc with chemistry honors in 1942 and later joined the Aluminum Co. of Canada. In 1945 he was transferred to Kingston to edit the Abstract Bulletin and, in 1947, became head of the division of publications and documents. He's the author of several handbooks and v-p of the Association of Technical Writers.

Jenks

Problem

The Canada Cement Company required a conveyor belt that would handle cement clinkers at better than 250°F.



Solution

*Dunlop used *Polysar Butyl in its "Superhet" conveyor belting to achieve a 300% increase in serviceability.*

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Polysar synthetic rubbers and latices have proved to be the answer to a wide variety of industrial problems. Manufacturers have found that it pays to investigate the technical advantages of the various types of Polysar rubber. Whether rubber is now used in your product or not versatile Polysar could be the answer to your design problem. Why not discuss your needs with our technical staff? Contact the Sales and Technical Service Division.

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NOTHING PERFORMS LIKE RUBBER — *The best buy for your money*

Reports

News in brief from the world's producers

British plants in Canada

Nearly 800 British subsidiary plants are now established in Canada, with nearly 400 in Ontario, **Gordon Booth,** United Kingdom trade commissioner, said recently.

"The growth of this kind of company, that is, a company with a stake in Canada employing Canadians and often managed by Canadians, is, I think, the most effective answer to those critics who say that Britain does not understand what Canada expects in the way of delivery and service," said Booth.

Ceramic tools spotlighted

One of the most significant tool engineering developments in recent years—ceramic cutting tools—will share the technical program spotlight when the **American Society of Tool Engineers** observes its 25th anniversary this March, in Houston, Texas.

As part of a special program marking 25 years of service to industry, the public and the tool engineering profession, ASTE will present a "Ceramic Tooling Symposium."

Where will they come from?

If Canada is going to maintain its place as one of the world's leading industrial nations, our present force of some 40,000 engineers will, over the next twenty-five years, have to be increased from 120,000 to 160,000. Our scientific force of 20,000 will need to reach almost 80,000 and our present pool of technicians to multiply tenfold. That is the substance of a monumental report recently completed under the direction of **S. H. Deeks,** chief of engineering administration for Orenda Engines Ltd.

Sub-chaser silencing

One of the most difficult tasks in modern aircraft design is the soundproofing of cabins.

A project under way at **Canadair Limited** in Montreal, in connection with a CL-28 coastal patrol plane for the RCAF, is the first time such a project has been undertaken in Canada, say company officials. It puts the company in the forefront of what is considered a most difficult design problem.

In tackling the problem, Canadair engineers felt that a major modification of the soundproofing system of the Bristol Britannia, from which family the CL-28 was redesigned, was necessary because the craft would be using piston engines rather than turbines, and because of the necessity of maintaining high crew efficiency during the long radar watches of the anti-submarine mission.

Quebec engineers

The first meeting of the Quebec City chapter of the **American Society of Heating and Air-Conditioning Engineers** took place in that city on Dec. 13, 1956. At that meeting the new chapter received its charter and elected as its president Jean Veilleux, P.Eng.

Some saving!

Saving of 97% over previous deburring and finishing costs have won an Almco Supersheen award for **Canadian Pratt and Whitney Aircraft Company, Ltd.** of Montreal.

According to the CP & W report, the previous cost figure of $104.20 per thousand bushings finished on speed lathes and portable power tools was cut to $2.95 per thousand under the new program of barrel finishing.

Happy dilemma

Research in plastics is producing new materials and new products so fast that the industry is faced with a happy dilemma: What do we produce before a new discovery comes along to make the new product obsolete?

Fortunately, the predicted market for plastics is so large that little risk is incurred by going into production on an important and useful item. Production is currently running at the rate of 3½ billion pounds a year, an increase of 26% over 1956. This is equivalent to $1.8 billion, or about one half of one percent of America's gross national product.

Digital computers

Mathematical representation of physical problems, and numerical techniques for obtaining solutions by means of digital computers, will influence design engineering significantly.

This is the conclusion of E. E. Zwicky, Jr. of **General Electric Company** in a paper disclosing the profound effect of digital computers on the mechanical design of large steam turbines.

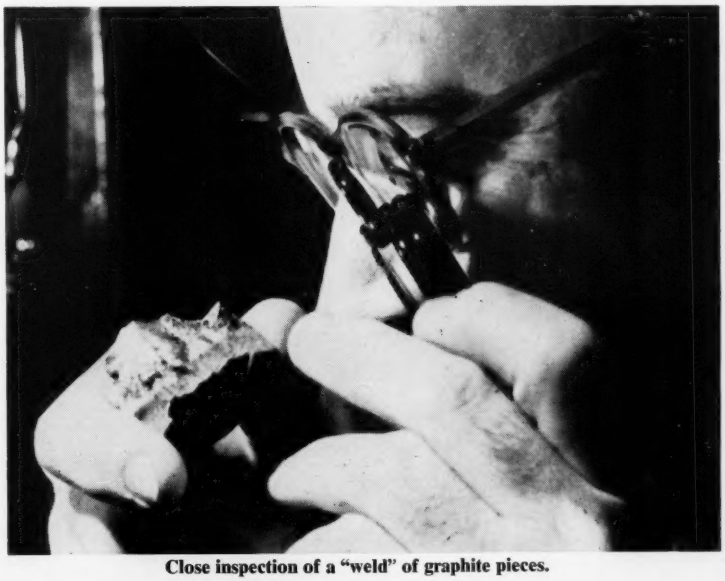
Capital Metal's acquisition

Capital Metal Industries Ltd., Toronto, have recently purchased the entire equipment of the New Haven Rivet and Manufacturing Co. This equipment, now installed in their Toronto plant, offers Canadian manufacturers a complete line of aluminum, steel, brass, copper, stainless steel (in fact any forgeable metal) and solid rivets in both standard and special designs.

Welding graphite

Dr. Robert G. Breckenridge, director of the new research laboratory of **National Carbon Co.,** has announced that company scientists have discovered for the first time in history how to "weld" pieces of graphite together, providing a new technique which promises advances in processing materials for the atomic age.

Pointing out the significance of welded graphite, Breckenridge said that it suggests the possibility of prefabricating sheets and panels for the assembly of nuclear reactor moderators which must now be built up from graphite blocks.



Close inspection of a "weld" of graphite pieces.

Leaders in the Age of Magnesium

"MAGNESIUM *is the backbone of our business"*

States T. R. B. Watson,
Corrosion Engineer,
Corrosion Services Ltd.,
Toronto, Ontario

"We started our business using Domal Magnesium because of its exceptional purity. Increasing quantities have been used in our protective installations both for pipelines and marine structures. Magnesium anodes are quick and easy to install and experience has proved them to be very effective."

From jet planes and heavy structural equipment to increasing numbers of household products . . . wherever lightness, strength, durability and versatility are demanded, modern engineers are finding more and more uses for

DOMAL HIGH-PURITY MAGNESIUM

THE WORLD'S LIGHTEST, MOST VERSATILE METAL

DOMINION MAGNESIUM LIMITED

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The original engravings for this advertisement were made on magnesium

DU PONT CANADA

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Many design improvement opportunities possible with ZYTEL* nylon resin

PRODUCTS molded from ZYTEL nylon resin are light in weight, strong and tough even in thin sections. They are resilient, resist permanent deformation and absorb shock and vibration. ZYTEL retains its form stability at high temperatures and its impact strength and flexibility even below zero. Parts of ZYTEL offer high hardness, excellent abrasion resistance and low coefficient of friction—require little or no lubrication for long service and quiet operation.

In addition to these superior mechanical properties, ZYTEL is unaffected by oils, grease, electrolytic corrosion and most solvents or chemicals. ZYTEL fits into many electrical applications because of its heat resistance and insulating properties.

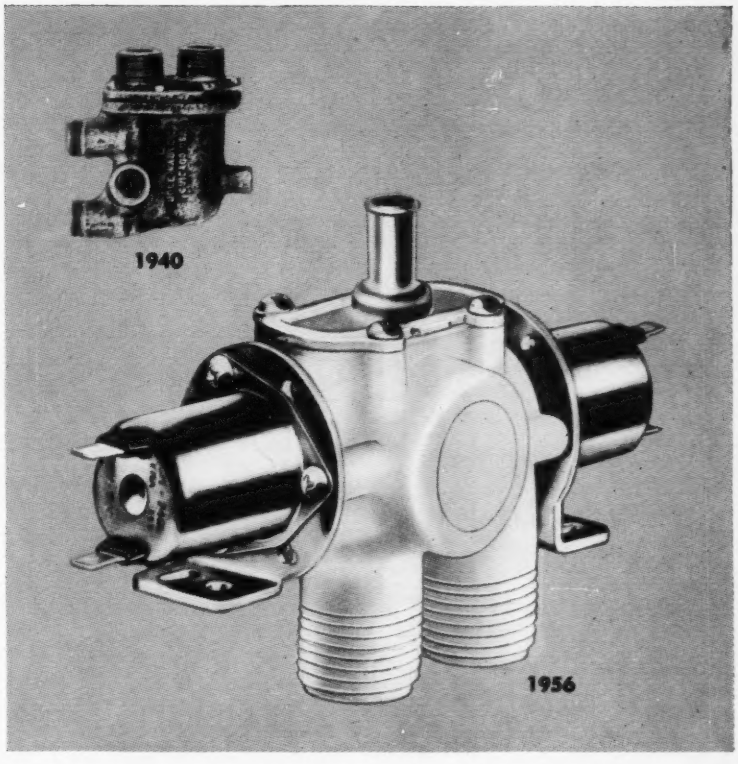
DuPont ZYTEL is readily molded to close tolerances and easily machined on standard metal-working equipment. You'll find that articles of ZYTEL provide superior performance at substantial savings in cost.

Examples of improved product design shown on the following pages illustrate the unusual versatility of Du Pont ZYTEL for mechanical parts. Abrasion resistance, impact strength and low coefficient of friction of ZYTEL result in quieter operation and superior performance with reduced maintenance for bearings, gears and cams. Light in weight, strong in thin sections, and able to be accurately molded into complex shapes, ZYTEL often permits simplified one-piece design to replace an assembly of parts. Because ZYTEL is inert to oils and most chemicals—retains its properties at high or low temperatures—it finds many applications where ordinary materials would quickly fail.

Check the designs on the following pages. You may find that, by incorporating parts molded of ZYTEL nylon resin in your product, improved performance and reduced costs will result.

Complete property and application data on Du Pont ZYTEL are available to you. Mail the coupon on the last page of this insert.

OVER



The valve housing of this automatic home washer is an example of the design improvement possible with ZYTEL. The inlets of the solenoid-operated Dole Water Control Unit provide a leakproof connection with standard hose couplings. The resistance of ZYTEL to water and chemicals prohibits corrosion, reducing maintenance and replacement costs. (Valve molded by Chicago Molded Products Corporation of Chicago, for The Dole Valve Company, Chicago, Illinois.)

*"Teflon", "Zytel", "Alathon" and "Lucite" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)

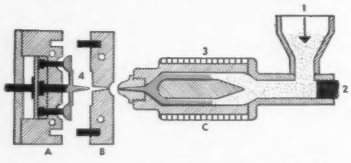
DU PONT CANADA

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Injection molding process is rapid production method

INJECTION molding is one process for producing large quantities of plastic parts. A typical injection-molding assembly, shown in the diagram, operates as follows:



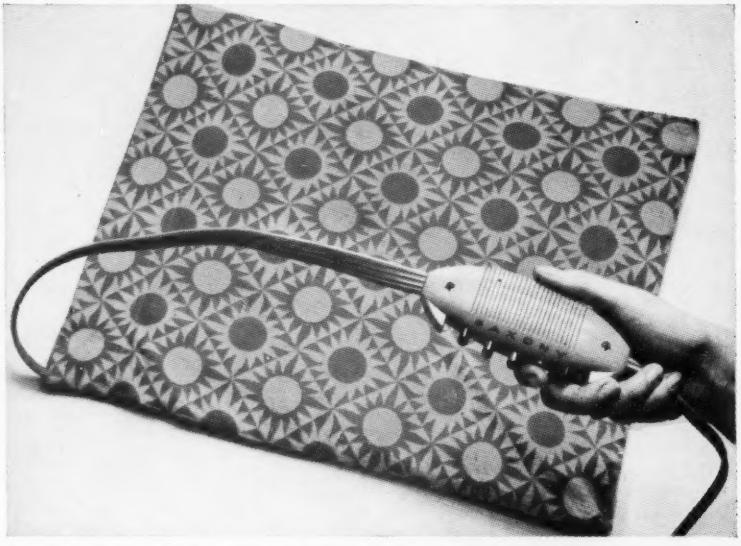
Parts marked *A* and *B* close and lock to form the *mold;* they move to contact part *C*, which contains molten plastic. Measured quantities of the granulated plastic (*1*) are fed into the machine. The reciprocating *ram* (*2*) forces this material into the *heating chamber* (*3*), where the powder liquefies. Each forward motion of the ram (*2*) forces molten plastic into the closed mold (*A* plus *B*), where the plastic solidifies and forms the *molded part* (*4*). Then the mold opens as shown in the diagram and the plastic part is ejected. In the meantime, the ram moves back, allowing more powder to feed into the machine, preparing it for another molding cycle.

The production rate depends on a number of variables, including the size of the part and the number of identical cavities cut into the mold. If molded parts are small, dozens of them can be made at one shot, whereas large parts may be produced one at a time. Cycles of 1 or 2 moldings a minute are not uncommon.

Here are some of the advantages of injection molding:

1. High rate of production
2. Economical production in quantity
3. Little or no finishing cost
4. Parts molded to close tolerances.

Economical and durable control switch made with ZYTEL* nylon resin



The durability and impact resistance of ZYTEL permit reduced costs in the Saxony switch, because less wall thickness is required. The multiple switch controls the temperature of electric heating pads and is molded by Wilmington Plastics, Wilmington, Del., for Saxony Electronics of Wilmington.

FUNCTION and appearance, coupled with cost, are important factors in the design of a new product. Because of this, the Saxony multiple switch, which controls the temperature of electric heating pads, is molded of ZYTEL.

ZYTEL was chosen for the Saxony switch because of its durability and impact strength, even in thin sections. The thinner walls of ZYTEL result in economy of material, and a reduction in costs.

Its low coefficient of friction gives ZYTEL excellent bearing characteristics. For this reason, the moving parts of the switch are also molded of ZYTEL nylon resin.

Available in white and in a wide range of colors, ZYTEL nylon resin permits a variety of design possibilities. Readily molded to close tolerances, ZYTEL is an excellent material for applications such as the Saxony switch.

For complete information on this versatile material—property tables, typical applications, and production techniques—simply clip and mail this coupon.

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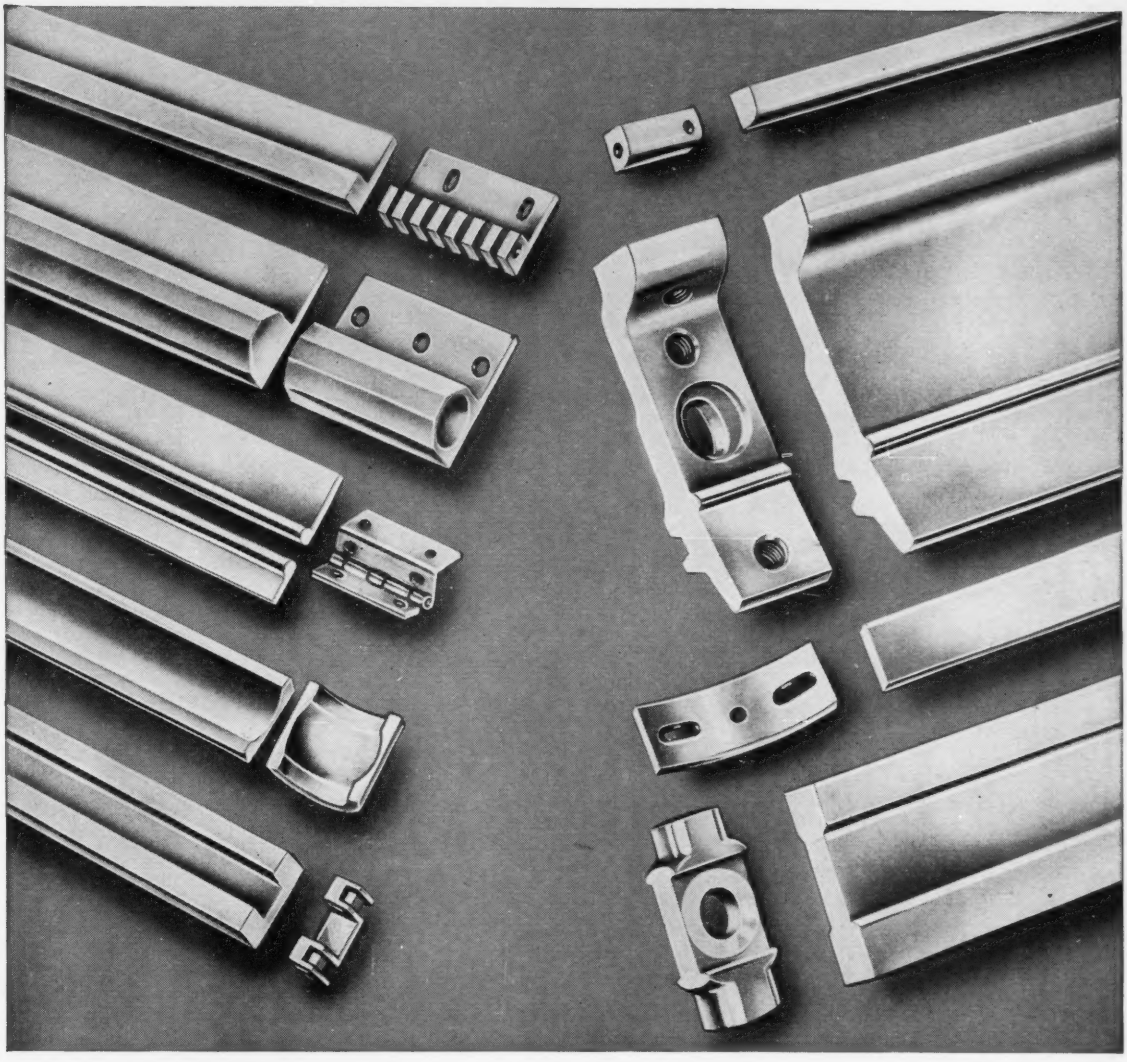
NEED MORE INFORMATION?

Clip the coupon for additional data on the properties and applications of this versatile Du Pont engineering material.

A SHORT CUT TO A FINISHED PRODUCT



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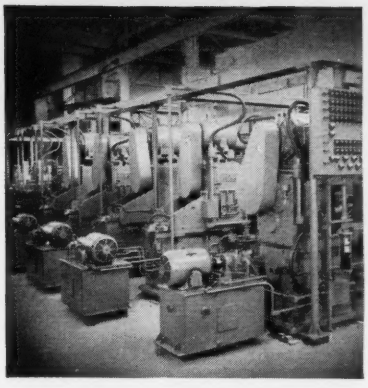
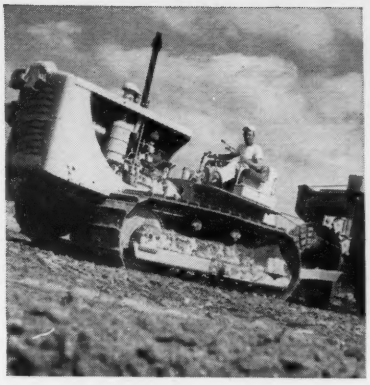
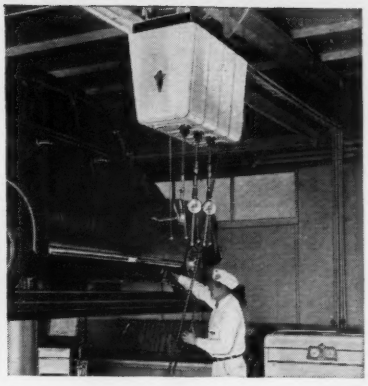
1. *Use of 0.12% maximum carbon content material for ease in hand bending and flaring.*
2. *Use of non-aging steel to prevent loss of ductility during storage and from service fatigue.*
3. *Careful inspection of raw material and in in-process stages.*
4. *Controlled atmosphere annealing for bright scalefree outside and inside diameter.*
5. *Mandrel-drawn close to finish size for smooth inside diameter.*
6. *Assured cleanliness by hot solvent degreasing before all process anneals and shipment.*
7. *Flare inspected on basis of 35% minimum increase on outside diameter.*
8. *100% hydrostatic pressure testing to recommended maximum working pressures.*
9. *All tubing dipped and drained in light, filtered rust preventive.*
10. *Boxed and wrapped in waterproof paper for cleanliness and protection from bending and denting during shipment and in warehouse stock.*

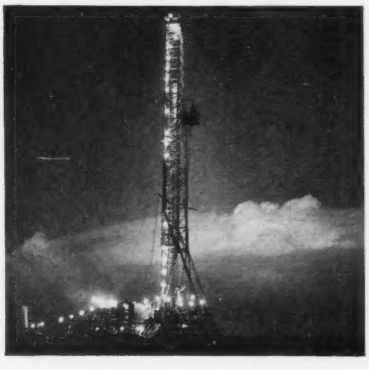






PRACTICAL APPLICATIONS FOR SUPERIOR SAE HYDRAULIC TUBING

Shown here are just a few of the many applications for Superior low-carbon steel SAE hydraulic tubing. (*Beginning at top left*) hydraulic lines on machine tools; construction and agricultural equipment control lines; hydraulic lines for lifts and grease guns in service stations; materials handling equipment; oil-well drilling equipment; oil and fuel lines on aircraft (AMS 5050 E).



When you need a hydraulic system that is dependable and leakproof, specify Superior SAE hydraulic tubing. We specialize in producing seamless low-carbon steel tubing for all hydraulic purposes. In many cases it is produced to specifications higher than standards called for by SAE.

Of Superior's many sizes in hydraulic tubing, some can bear working pressures as high as 12,000 psi. The steel from which it is produced has a maximum carbon content of only 0.12%, which results in high ductility and permits easy hand bending and flaring . . . necessary bends can be made neatly without pinching. Each order of tubing is 100% hydrostatically tested at maximum working pressure. And efficient quality control assures close adherence to specified tolerances. Finished tubing has clean, bright, smooth inner and outer surfaces. It is furnished in dead soft-annealed temper for ease in bending, and is available in cut, multiple or random straight lengths up to 30 feet, or longer in coiled form.

Whatever your hydraulic tubing requirements or problems may be, bring them to Superior. Our extensive facilities and years of experience are at your service. Superior SAE hydraulic quality tubing is stocked by warehouses in principal cities throughout the U.S.A. For additional technical data on hydraulic tubing, write for Bulletin No. 39. Superior Tube Company, 2031 Germantown Ave., Norristown, Pa.

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Lyman Tube & Bearings, Ltd., Montreal, Toronto and Winnipeg

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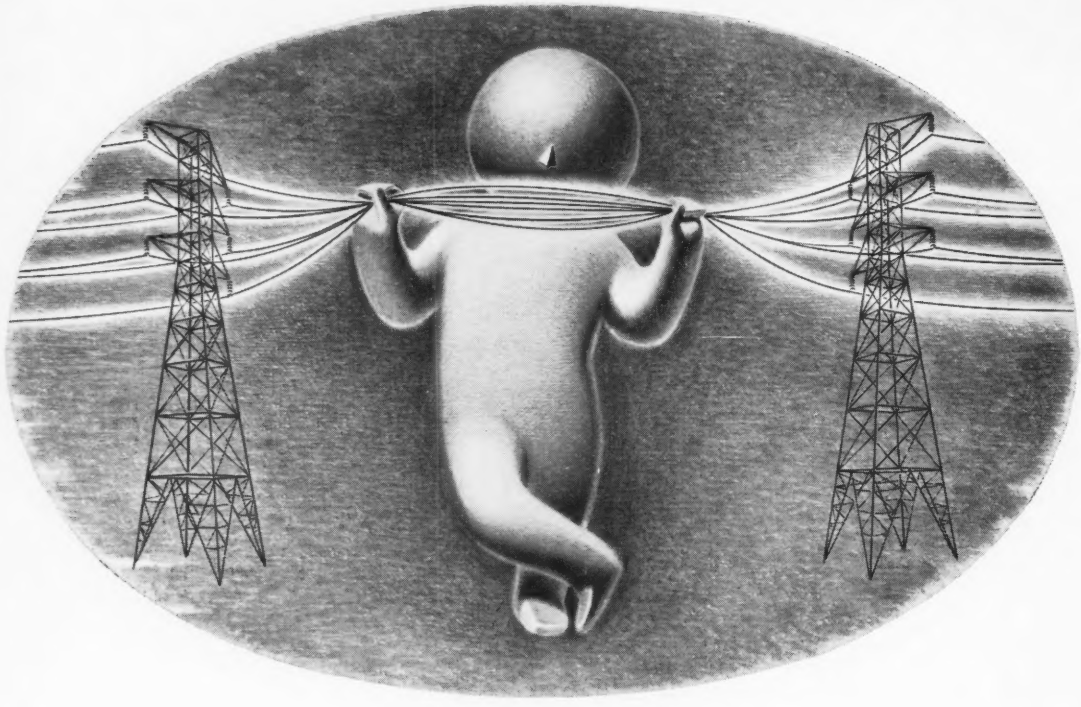
ELECTRICAL PROPERTIES

of G-E silicone rubber AT HIGH TEMPERATURES?

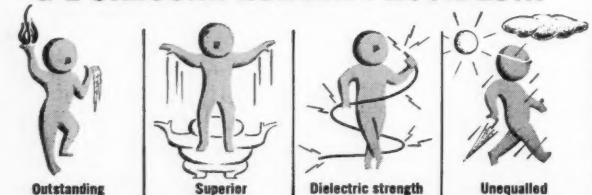


Amazing electrical properties at high temperatures are among the outstanding characteristics of General Electric silicone rubber. It is ideal for wire and cable insulation where overloads or space limitations dictate a heat-resistant dielectric. Cables have been redesigned with G-E silicone rubber to carry nearly *twice the current—with no increase in size!* G-E silicone rubber not only provides Class H insulation, but can be used to improve Class B insulation as well.

Where can YOU use G-E silicone rubber? There's a kind for almost every requirement, classified according to dominant property for easy selection and specification. For example: Class 300 offers the best recovery after compression *of any known rubber!* Class 500 provides flexibility *at 130°F below zero!* Which class is best for *you?*

SEND FOR A FREE
***"LIGHTNING SELECTOR"*—TODAY!**

G-E SILICONE RUBBER PROVIDES...



Outstanding resistance to extreme temperatures

Superior resistance to compression set

Dielectric strength stable at high temperatures

Unequalled resistance to aging, ozone, weathering

Chemical Material Sales

INDUSTRIAL PRODUCTS DEPARTMENT

CANADIAN GENERAL ELECTRIC COMPANY
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Chemical Material Sales
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1601 Davenport Rd.
Toronto, Ontario

Please send me technical data on G-E silicone rubber, including a free "Lightning Selector".

Name_____ Position_____

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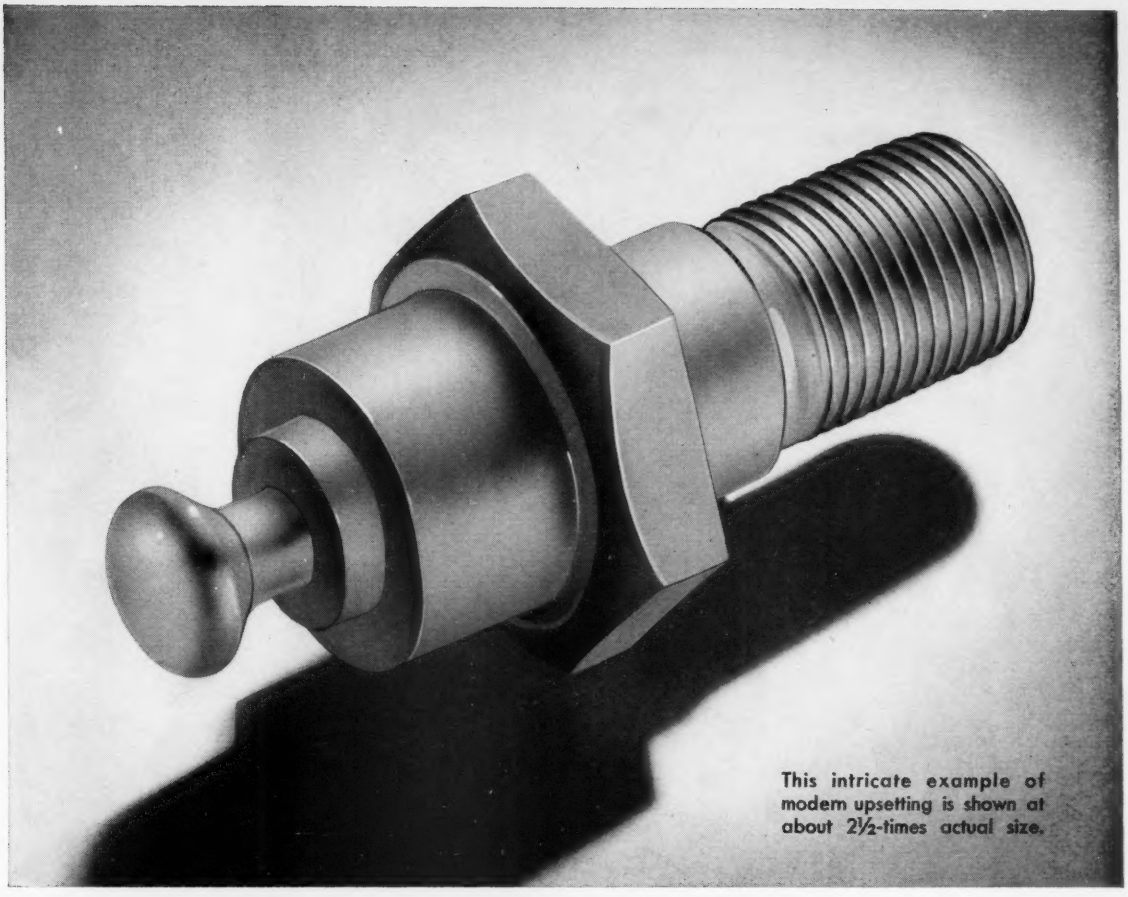
457W-656



This intricate example of modern upsetting is shown at about 2½-times actual size.

How much would YOU save with a . . .

STELCO SPECIAL FASTENER ?

- *If you use a machined part . . .*
- *If you "make-do" with a standard fastener . . .*
- *If you use a forged fastener . . .*
- *If you have a fastener design problem . . .*

STELCO can probably save you money with a SPECIAL FASTENER

Where Special Fasteners are used the saving is not only in parts at a lower cost . . . but in faster, better assembly as well.

The Fastener shown above indicates the extremely wide design possibilities of Stelco Special Fasteners. The range of contoured and special shapes produced by Cold Heading is increased by threading, punching, shaving, and bending operations.

Cold Heading saves material and production time. Cold Headed parts are stronger and cheaper than similar machined pieces, cheaper than forgings and equally strong.

Stelco's Engineering Service can advise if a Special Fastener would be beneficial in *your* operation . . . if so, there is a substantial saving for *you*. Contact any Stelco Sales Office for further information.

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Sales Offices: Halifax, Saint John, Montreal, Ottawa, Toronto, Hamilton, London, Windsor, Winnipeg, Edmonton, Vancouver.
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Jenkins Bros. has remained the leader in composition disc development and production since 1864, when the first renewable disc valve was introduced.

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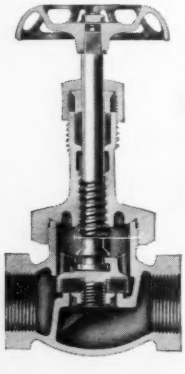
Ask your Jenkins Valve Distributor for Disc Folder Form 203, or write: Jenkins Bros., 617 St. Remi Street, Montreal.



. . . for highest efficiency, use the time-proved combination . . . JENKINS DISCS in

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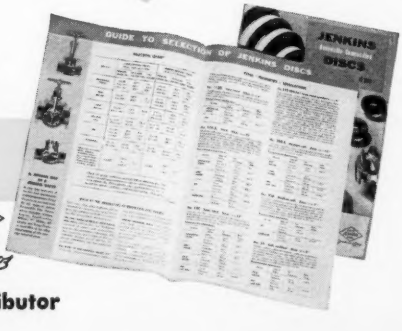

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ultimate versatility in solving complex technical problems...

The general purpose digital computer solves most scientific and engineering problems with speed and accuracy... yet easier programming makes the digital differential analyzer a superior choice for solving differential equations. Bendix now combines the advantages of both in the *new* G-15D Computer and its optional DDA accessory. Working together, and supported by a full complement of input-output equipment, these units provide the *best* means of solution. And the rental or purchase cost is far below that of most general purpose computers alone.

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If the appliance doesn't work, she won't blame the spring maker . . . she'll blame *YOU!*

A basketful of laundry and a broken spring! Bad combination? . . . you bet! . . . and especially for the dealer who sold the appliance. The housewife will never appreciate that it was "just a spring" . . . all *she* knows is that the ironer wouldn't work and her husband's shirts didn't get done!

Get the housewives soured on you, Mr. Appliance Maker, and you've lost your market. In manufacturing, you can buy *quality* parts and *build* your market or you can scrimp pennies and drive your market away. Wallace Barnes are proud of the technical precision of *all* the springs they make . . . springs that can build goodwill for your products.

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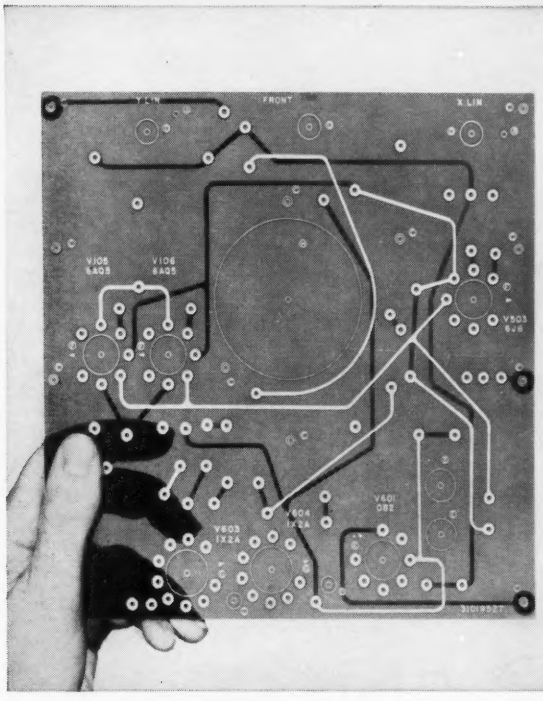
Below . . . No problem with electrical properties when your printed circuits are based on XXXP laminates made with RCI PLYOPHENS 5027 and 5036.

Photos courtesy of The Formica Company



Above . . . You cut treating machine time when filler sheets for high pressure decorative laminates are made with RCI PLYOPHEN 5573.

Left . . . You reduce stack losses when you use PLYOPHEN 328 for binding fibrous glass or mineral wool into insulation batts. And P-328's low alkalinity definitely improves the water resistance of the insulation.

fast cures and sure results...

when you use RCI liquid phenolic resins . . . *job-designed* for your laminating and bonding needs.

Reichhold has a PLYOPHEN liquid phenolic tailored to your exact need . . . whether the resin is going into the manufacture of printed circuits, into a binder for fibrous glass or mineral wool insulation, into filler sheets for decorative laminates, or any one of scores of other products.

PLYOPHENS are *job-designed* to assure fast production *and* uniform results. RCI controls quality all the way . . . right from the beginning, by producing its own phenol and formaldehyde.

Write us the details of your phenolic resin application and ask for a *sample* of the RCI liquid phenolic that will do the job best. Then try it out and see if you don't get superior results.

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Phenol • Formaldehyde • Glycerine • Phthalic Anhydride
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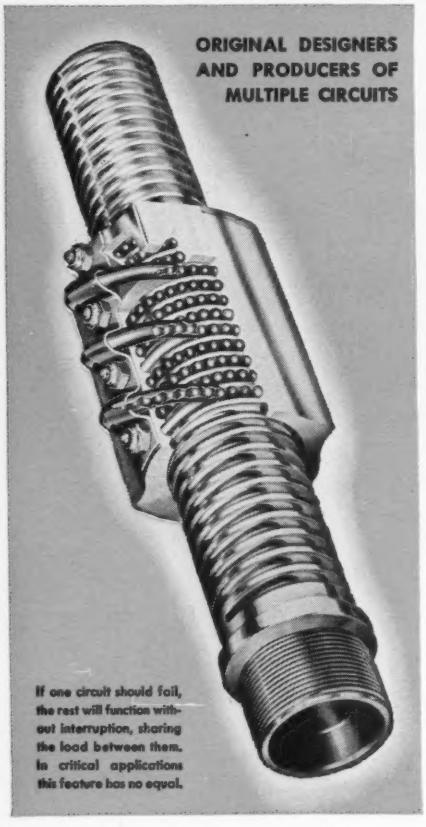
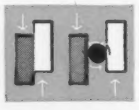
SAGINAW b/b SCREWS are guaranteed 90% EFFICIENT!

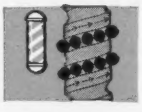
Require 4/5 LESS torque than Acme Screws for same linear output on Actuator and Positioner Applications! Saves space, weight!


ORIGINAL DESIGNERS AND PRODUCERS OF MULTIPLE CIRCUITS
If one circuit should fail, the rest will function without interruption, sharing the load between them. In critical applications this feature has no equal.

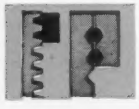
WHAT IT IS AND HOW IT WORKS



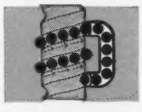
Let's start at the beginning, with the familiar principle that there's far less friction in *rolling* than in *sliding*. By applying this principle,



Like stripes on a barber pole, the balls travel toward end of nut through spiral "tunnel" formed by concave threads in both screw and mating nut.



the *Saginaw ball/bearing Screw* radically increases the efficiency of rotary-to-linear motion (and vice versa). Instead of *sliding*, mating surfaces *glide* on rolling steel balls.



At end of trip, one or more tubular guides lead balls diagonally back across outside of nut to starting point, forming closed circuit through which balls recirculate.

SIX DESIGN ADVANTAGES

1. Vital Power Savings. Permit much smaller motors with far less drain on electrical system, simpler circuitry.

2. Space/Weight Savings. Screws themselves are smaller, lighter; permit smaller motors and gear boxes; eliminate auxiliary equipment required by hydraulics.

3. Precise Positioning. Machine-ground type will position components far more precisely than hydraulics or pneumatics; tolerances on position are held within .0006 in./ft. of travel.

4. Temperature Tolerance. Normal operating range from —75° to +275° F.; in selected materials, will function efficiently as high as +900° F.

5. Lubrication Latitude. If lube fails, will still function with remarkable efficiency. Units have been built and qualified for operation without lubrication.

6. Fail-Safe Performance. Far less vulnerable than hydraulics; Gothic-arch grooves, yoke deflectors and multiple circuits provide added assurance against failure.

SAGINAW b/b SPLINE

Utilizing the same basic *gliding ball* principle, Saginaw has developed the *Saginaw b/b Spline* which radically increases the efficiency of transmitting or restraining high torque loads.

Averages 40 times lower friction coefficient than sliding splines!

It can be fitted with integral gears, clutch dogs, bearing and sprocket seats, etc., for use with a wide variety of electrical units. Units have been built from 3 inches to 10 feet long—⅜ to 6 inches in diameter.

Available in custom machine-ground and stock rolled-thread types. Units have been built from 1½ inches to 39½ feet long—⅜ to 10 inches in diameter.

Saginaw ball bearing Screws & Splines

SAGINAW STEERING GEAR DIV., GENERAL MOTORS CORP., SAGINAW, MICH.

SEND COUPON FOR NEW 1957 ENGINEERING DATA BOOK

Saginaw Steering Gear Division, General Motors Corp.
b/b Screw and Spline Operation
Dept. 6W, Saginaw, Michigan

Please send new engineering data book on Saginaw b/b Screws and Splines to:

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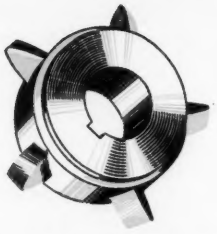
Gears



Hamilton Gear-designed multi-tooth fly cutter which saved several thousand dollars in producing wormgear shown in photograph.

We're accustomed to challenges at Hamilton Gear. An excellent example is the worm and gear illustrated above, produced for a steel mill installation. We're reasonably sure no other manufacturer in Canada could have made this worm and its mating gear. The worm has 10 threads instead of the normal maximum of 6, and the highest possible lead angle (about 45°, or 15° above the usual maximum). For this operation, we designed a special fly cutter which "generated" the gear as perfectly as a conventional hob, but cost only a fraction as much. On special orders like this—as well as on standard gear requirements—our unrivalled know-how and production facilities have been saving money for Hamilton Gear customers for over 40 years.

Hamilton Gear and Machine Co., Limited.

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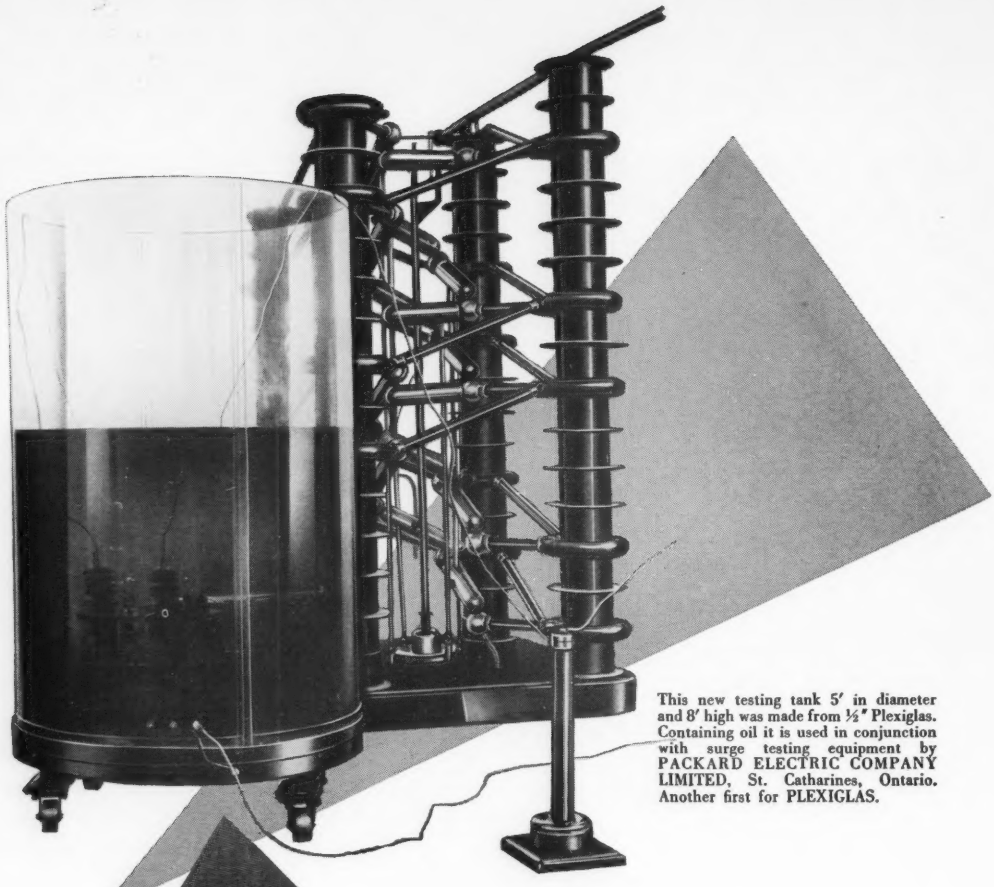
Spur Gears *Helical Gears* *Herring-Bone Gears* *Bevel Gears*

In all sizes for every industrial application— *Wormgears* *Spiral Gears* *Speed Reducers* HG-T-2-55



This new testing tank 5′ in diameter and 8′ high was made from ½″ Plexiglas. Containing oil it is used in conjunction with surge testing equipment by PACKARD ELECTRIC COMPANY LIMITED, St. Catharines, Ontario. Another first for PLEXIGLAS.

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Why do men who know choose PLEXIGLAS? Its *versatility* is the reason. PLEXIGLAS, has strength, optical clarity — is resistant to many solvents — and can be easily moulded.

These factors tell why PLEXIGLAS has proven itself in industry. New applications are continually being found. Plexiglas is in service in almost every industry.

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Bolts and other fasteners made from Noranda Silicon Bronze 609 have the strength and toughness of some grades of steel, and in addition offer excellent resistance to most corrosive environments.

Hard-drawn Noranda Silicon Bronze wire retains its malleability to a surprising degree. It is easy to form and it work-hardens rapidly without developing brittleness. Large headed bolts with tensile strength in the range of 100,000 psi can be produced by cold-heading and roll-threading without intermediate anneals or final heat treatment. Silicon Bronze nuts made by cold-upsetting are remarkably strong, too.

For chemical hardware, pole line hardware and fasteners for other severe service applications where dependability is vital, specify Noranda Silicon Bronze.

Your nearby Noranda Sales Office will be happy to give you complete information about Noranda Silicon Bronze or other superior copper-base metals in strip, rod, wire or tube.

Noranda Copper and Brass Limited

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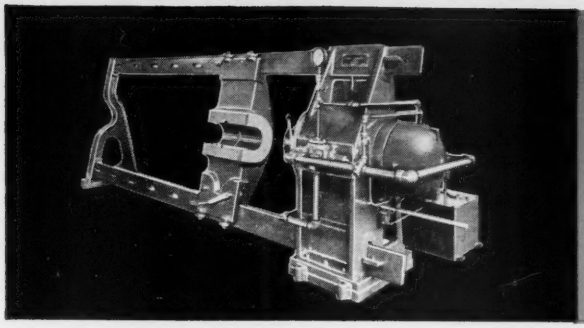

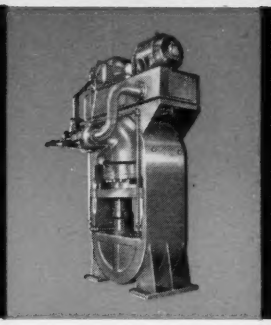

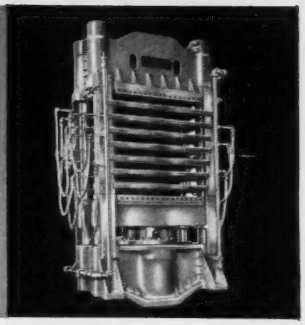

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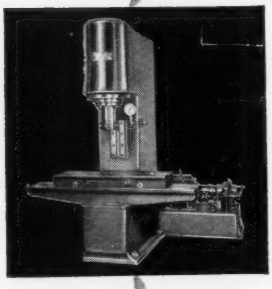

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HYMAC specialists available for consultation and service
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BALL BEARINGS ACTUAL SIZE

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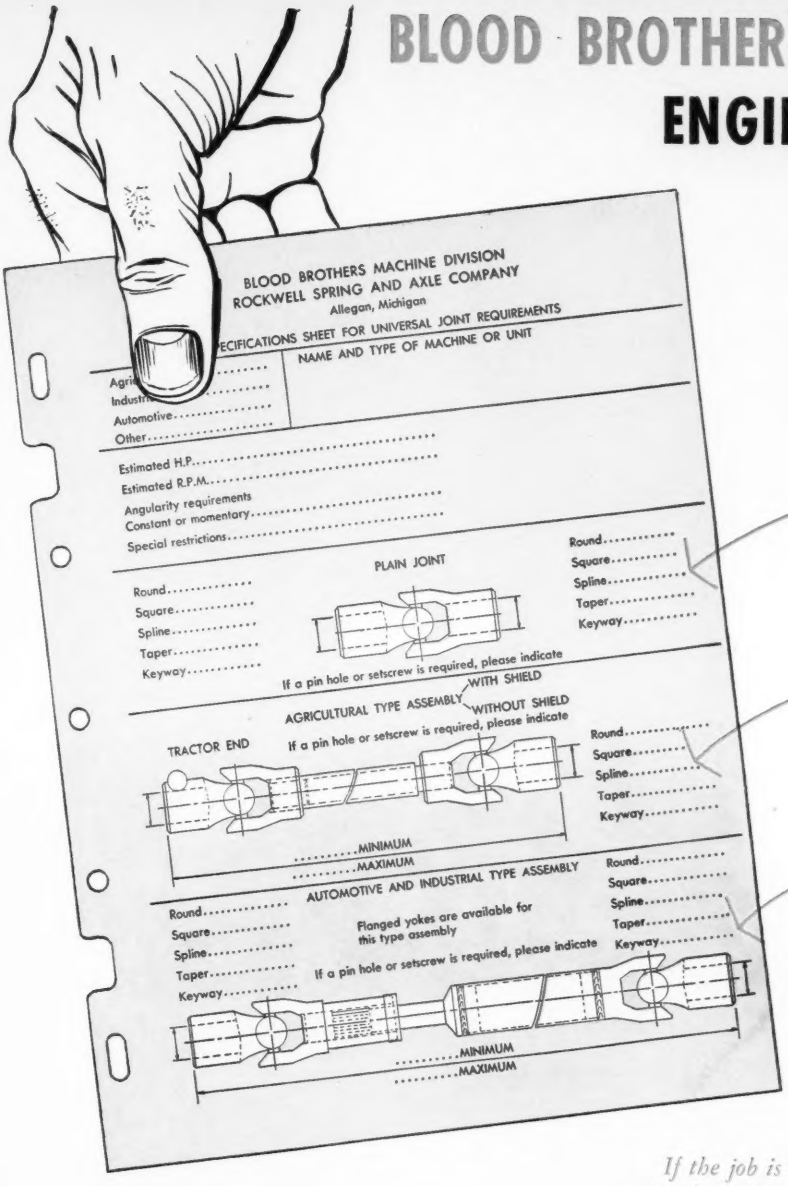
BLOOD BROTHERS makes your ENGINEERING JOB *EASIER*



. . . regardless of whether your project requires a single universal joint such as this

. . . a complete agricultural type assembly

. . . or an automotive or industrial truck propeller shaft like this

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This service is offered without extra charge because *we* can work more efficiently with all the facts in hand.

Blood Brothers builds *more standard types and sizes* of universal joints than any other manufacturer (from 300 up to 89,300 torque inch pounds continuous load).

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CENTRIFUGALLY CAST STAINLESS STEEL

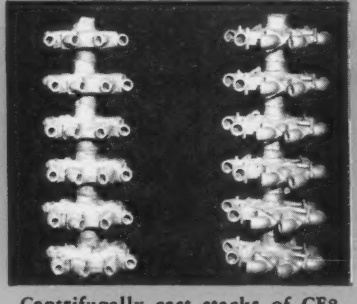
YIELDS A SUPERIOR CASTING! OFFERS ADDED ECONOMIES!

In the production of cylindrical shapes, and for small castings of irregular shape, the *Centrifugal Casting Method* yields a quality product much superior to that produced as a static casting.

And Shawinigan PERMA-SPUN offers significant economies over drawn tubing. Even on small quantities of any specific analysis the cost is low, and on large runs permanent molds can be used permitting a thinner wall and less machining allowance.

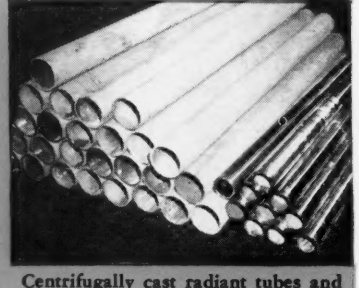
Centrifugal Force ensures complete freedom from non-metallic inclusions and shrinkage and creates a dense, fine-grained casting with enhanced physical properties.

Centrifugally cast CF10M pipe for sulfite acid circulation systems.



Centrifugally cast stacks of CF8 fittings (as cast condition).

Centrifugally cast HU retorts for magnesium production.



Centrifugally cast radiant tubes and rolls for heat treating furnace — cast in permanent molds.

Illustrated are a few of the many applications of *PERMA-SPUN* corrosion and heat-resistant stainless steel. Consider the possibility of saving money in your operations with "Shawinigan" *PERMA-SPUN* centrifugally cast Stainless Steel!

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SHAWINIGAN TRADE MARK REGISTERED

SHAWINIGAN CHEMICALS LIMITED

STAINLESS STEEL AND ALLOYS DIVISION

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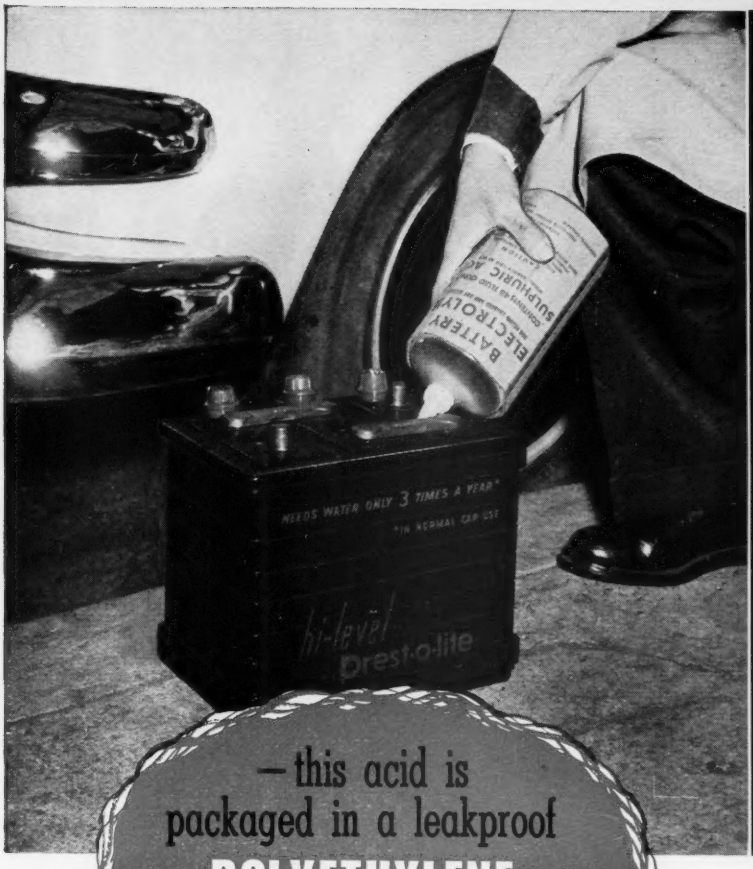

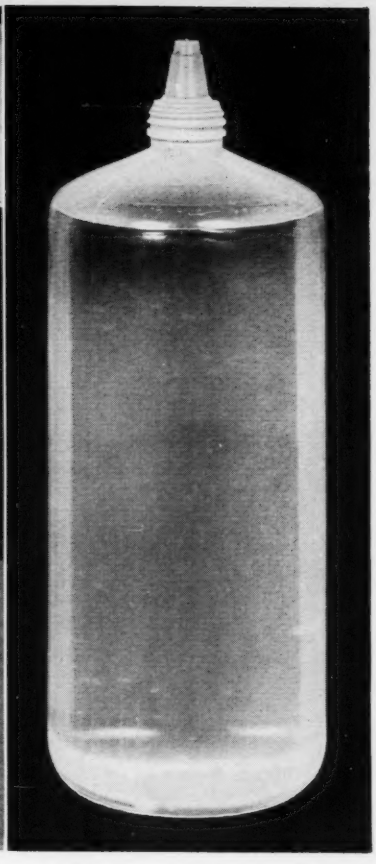

48-ounce-capacity, light-weight bottle is moulded by Plax Canada Limited, Georgetown, Ontario, for manufacturers of Dry Charged batteries.

— this acid is packaged in a leakproof **POLYETHYLENE** container made by Plax Canada Limited

The shipping and handling of battery acid demands a leakproof, safe, economical container, made in a shape preferred by the battery dealer for easy pouring. Plax Canada Limited produced the answer in moulding this bottle-shape container made of "Bakelite" Polyethylene.

Here is another example of how Polyethylene is "fitting into the packaging picture", just as it is in many other applications for industry, the consumer field and for agriculture.

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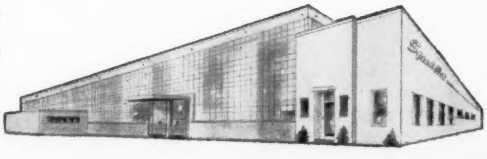

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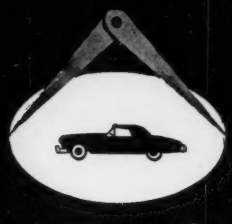
NEOPRENE • HYPALON®



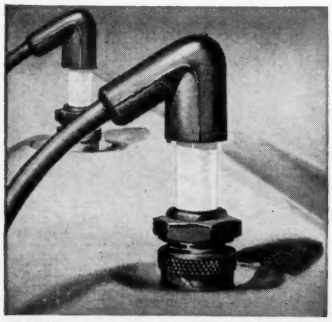
in Design

HYPALON® solves some heat and ozone problems for resilient materials

HYPALON is completely unaffected by ozone, and, when it is compared with other kinds of rubber, it also shows unusual resistance to hardening at elevated temperatures (250°-350°F.). These two facts offer new opportunities to design engineers who are faced with the problem of using resilient materials in today's high-powered engines.

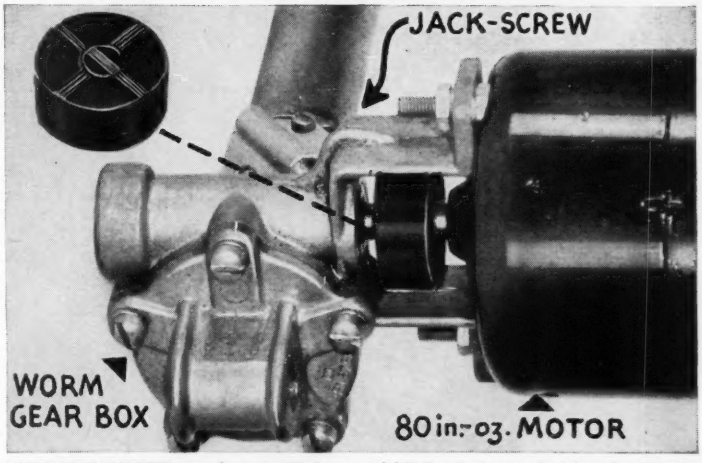
Already HYPALON is being used in molded spark-plug boots (see photo below) and ignition cable jacketing. In these applications, HYPALON's superior resistance to heat, plus the fact that it is completely unaffected by ozone, makes it a logical choice. HYPALON is the most economical choice in the long run, too, because it gives an extra-long service life to any product exposed to heat and ozone.

HYPALON has many other uses in the automotive industry. It's being used as a protective coating on rubber door stripping for automobiles because it protects against deterioration by sunlight and weathering. Durable HYPALON also can be compounded in an unlimited range of *light-fast* colors to blend with the modern fabrics and exterior paint colors of today's cars. These are just a few examples. For further information on HYPALON, just mail the coupon.



MOLDED spark-plug boots of HYPALON withstand high temperatures, are unaffected by ozone.

NEOPRENE flexible couplings in seat adjustor last well over 30,000 cycles



FRONT-SEAT ADJUSTOR propels seat with force of 1,200 lbs. Jackscrew is driven by 80 inch-ounce motor through neoprene coupling and worm gear.

Neoprene chosen for resilience, resistance to oil

The auto company that uses this seat adjustor has a test requirement of 30,000 cycles, operating a standard seat loaded with 450 lbs. When the unit was first designed, the manufacturer used a barrel spring for the coupling. It proved to be too noisy and barely lasted through 10,000 cycles before it failed.

The solution to the problem was the flexible coupling shown above. It consists of two flat metal inserts molded into a neoprene disk. One insert engages the worm shaft; the other engages a slot in the end of the motor shaft. Neoprene was chosen as the elastomer for the coupling because its resilience assured a quiet operation of the adjustor, and its superior oil resistance guaranteed long life to the coupling. The coupling is subjected to occasional contact with oil coming from the worm shaft.

NEOPRENE couplings outlast metal seat

The auto company's test engineer says he can't recall a neoprene coupling ever failing to pass 30,000 cycles. "In fact," he says, "in tests run to destruction, the coupling was still going strong when the seat itself was completely shot!"

This is just one example of neoprene's proven performance. Its resistance to oil, heat, weather and sunlight has led to its use in many other automotive applications. For more information on design problems solved through the use of neoprene, mail the coupon below.

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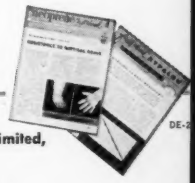

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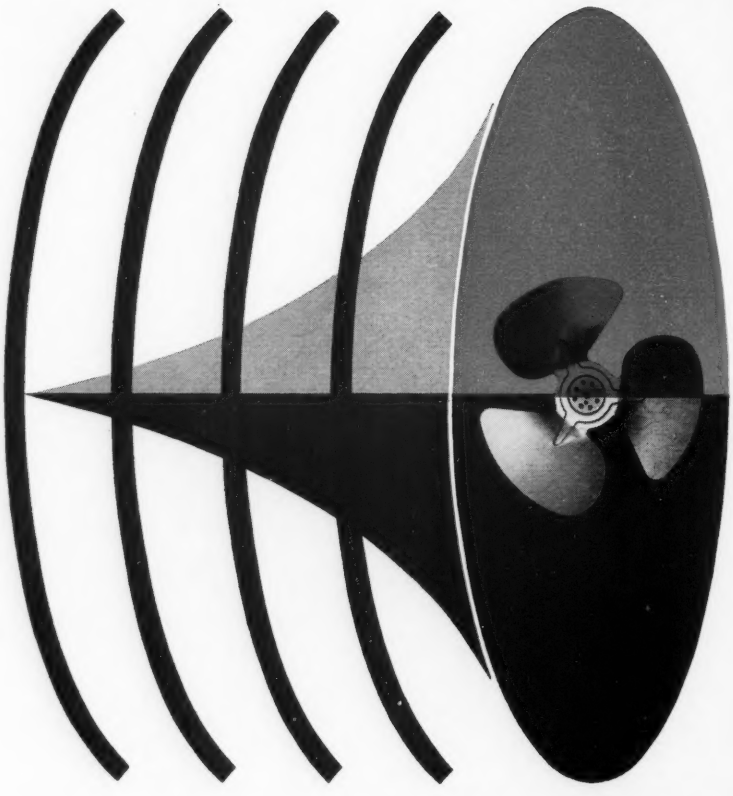

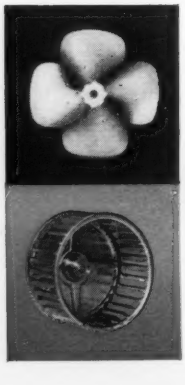

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People

Important people who are in the news

Managerial status

The post of Chief Design Engineer at Orenda Engines Ltd.—now held by **Burt A. Avery**—has been elevated to managerial status.

Mr. Avery, 34, graduated in mechanical engineering from the University of Toronto in 1946, joining Orenda's engineering department the same year. He attended school earlier in Weston and Kirkland Lake.

He was appointed Chief Design Engineer in 1954 and previously held the posts of Assistant Chief Design Engineer and Acting Chief Design Engineer.

Clarke is appointed

Kenneth H. J. Clarke has been appointed manager of Canadian sales and market development of the International Nickel Company of Canada Ltd.

In his new position, Mr. Clarke will direct Inco's Canadian sales, advertising, and market development and research activities.

A native of Toronto, he is a metallurgical engineering graduate of the University of Toronto, holding the degree of Bachelor of Applied Science. He joined International Nickel in May, 1936, as a metallurgical engineer in its copper refining division at Copper Cliff, Ontario.

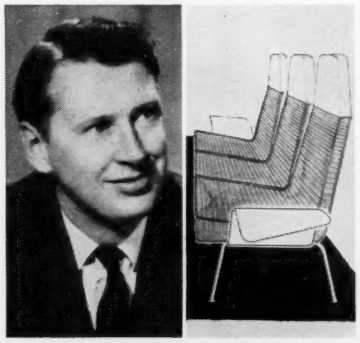
Oshawa designer wins

James Warren, Oshawa, has been named certificate of merit winner for his chair design in the Blocksom & Co. national furniture design contest.

Warren is in charge of product development for the R. D. Werner Co. (Canada) Ltd., in Oshawa.

The contest was open to professional designers in the United States and Canada. Judging took place in Chicago late in November and was done by a panel of five nationally-known figures in the design field. Prizes totaling $3,500 were distributed to the first three prize winners with eight other entries receiving certificates of merit.

Warren has won awards and honorable mention in three design competitions sponsored by the National Industrial Design Council in Ottawa. He is a member of the Association of Canadian Industrial Designers and is a graduate of the Ontario College of Art.



Oshawa designer Warren and his prizewinning chair

President of Ontario engineers

John Holloway Fox, P.Eng., O.B.E., of Toronto, has been elected president of the 15,000-member Association of Professional Engineers of Ontario, thus becoming chief executive of Canada's largest professional society, which serves as the licensing body for the province's engineering profession.

In business life, Mr. Fox is vice-president in charge of sales for Honeywell Controls Ltd. A graduate in mechanical engineering from University of Toronto in 1927, he has been associated with Honeywell since 1935. During World War II he served with the RCEME in Britain and northwest Europe, was awarded the O.B.E., and retired at the end of the war with the rank of lieutenant-colonel.

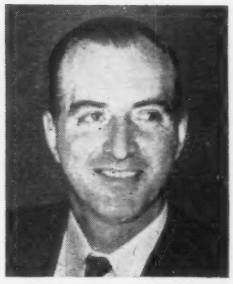
Canadian sales manager

F. J. Lockhart has been appointed to the position of manager, Canadian sales, at Atlas Steels Ltd.

Mr. Lockhart was born in London, Ont., but received his early education in Toronto. He attended the University of Toronto and graduated in 1941; B.A.Sc., metallurgical engineering. Two years later he joined Atlas Steels Ltd. as a member of their Hamilton branch sales force. In January of this year he became manager of tool steel sales—the position he held until his recent appointment.

Clarke

Fox



Lockhart

Resident technical rep.

Joseph P. Grove has been appointed resident technical representative for Canada for British Timken Ltd. and Lyman Tube and Bearings Ltd.

Mr. Grove joined British Timken in January 1946, as a service engineer. In the course of his duties he has visited all countries in western Europe and has also toured the Middle East and Yugoslavia. He made several trips to Canada prior to taking up his present appointment.

He has been engaged on work on rolling mills, railways, aircraft and heavy industrial applications.

He will be located in the Toronto office of Lyman Tube & Bearings Ltd.

Ferranti sales manager

Frank M. Squires, P.Eng., of Ferranti Electric Ltd., has been appointed sales manager of the transformer division of the company.

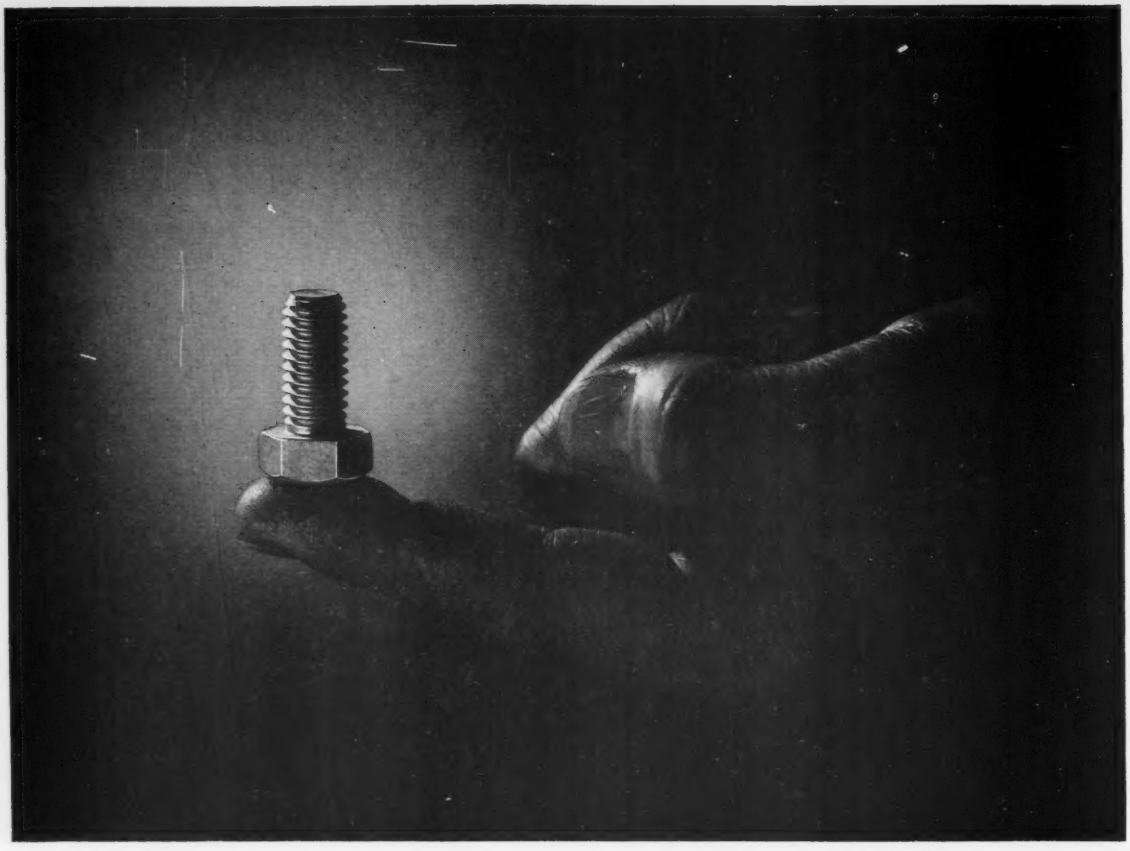
Squires is a graduate in electrical engineering from the University of Toronto and joined Ferranti in 1949. After an extensive factory training period he was appointed to the Ontario district sales department and in 1953 was promoted to sales promotion manager. He became Ontario district sales manager in 1955.

To speak on steel

The next meeting of the Ontario chapter of the American Society for Metals will be held at Toronto's Royal York Hotel on February 1. Speaker at that meeting will be **Samuel Epstein,** technical adviser, research department, at the Bethlehem Steel Co. Inc. Epstein, who is a graduate (BSc. Chem.) from the City College of New York in 1918, will speak on the "Ageing and embrittlement of mild steel."

Turbine specialist

David F. Abel, P.Eng., has been appointed turbine specialist for CGE in Saskatchewan, Alberta and British Columbia. Mr. Abel will provide specialized assistance to utilities and industries on the application of GE steam and gas turbines and generators. Specialist Abel has wide experience in his field in Canada, Britain and the U. S. His office will be in Calgary at 1023-11th Avenue West.



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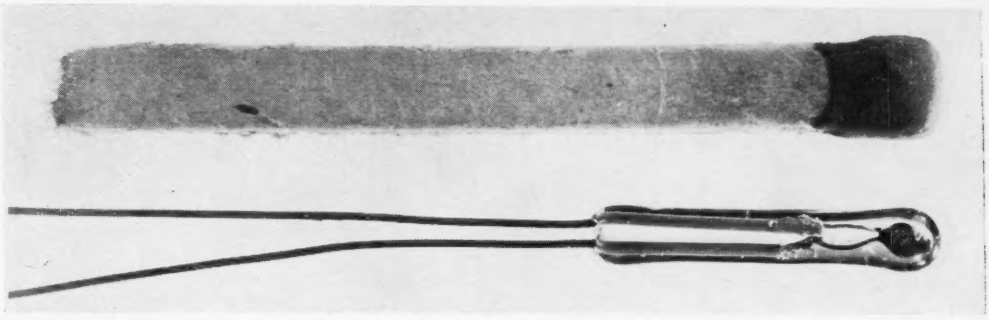


This photo, about 4 times actual size, emphasizes the minuteness of the glass bead type thermistor.

Those versatile devices–thermistors

When temperature increases, resistance goes down, and vice versa

By Robert S. Goodyear

Thermistors were so named by the Bell Telephone Laboratories and the name is a contraction for "thermal resistors."

They are thermal resistors with a high negative temperature coefficient of resistance. As the temperature increases, the resistance goes down and as the temperature decreases, the resistance goes up. This is just opposite from the effect of temperature changes on metals.

Thermistors are semi-conductors of ceramic material made by sintering mixtures of metallic oxides such as manganese, nickel, cobalt, copper, iron and uranium. Various mixtures of these metallic oxides are formed into useful shapes. Their electrical characteristics may be controlled by varying the type of oxide used and the physical size and configuration of the thermistor.

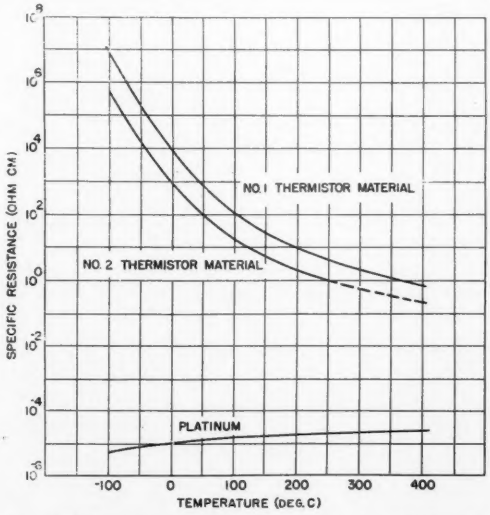


Fig. 1. Thermistor resistance compared to platinum.

Thermistors are not new. They have been known for about 150 years but have had very little use because they were considered to be unstable and nonreproducible. During the last 35 years various materials and processing procedures have been investigated to determine how to make stable and reproducible thermistors. It is only in the last five years, however, that thermistors have been generally available for large scale industrial use.

Many interesting applications for the commercial and industrial use of thermistors have been developed in the last few years, although such development has been very slow because of the lack of trained engineers who know how to use thermistors in electrical and electronic circuits. Thermistors are now available in a large variety of types covering a broad range of electrical characteristics. There are discs, washers, rods, beads and flakes capable of handling from a few microwatts to 25 watts and having a resistance range from a fraction of an ohm to 100 megohms, with time constants from a fraction of a millisecond to several hours. Resistance values are available in normal tolerances of 10 to 20% but many types can be obtained with tolerances as low as 1%. With this vast range of values available to engineers, it is no wonder that thermistors are finding their way into new equipment daily.

The materials and processes developed by Bell are for use primarily at relatively low temperatures of 300 deg C or less. Glass coated units may be used

at 300 deg C with very high stability. If the resistance of a new thermistor is plotted against the logarithm of time during which it is held at an elevated temperature (with the time co-ordinates being something like 1 day, 1 week, 1 month, 1 year or 10 years), the curve will be a rising exponential approaching an asymptote of a fixed resistance as time increases. Such a curve might have a total change of resistance of 2 to 3% over the whole time scale, with 90% of the change taking place in the first week. This leaves only 2/10 (or 3/10) of 1% change to take place through the years of use at elevated temperature. Units have been tested which were for use in gas analysis equipment and which had been aged at 300 deg C for 60 days and found to be stable over long periods of time to better than 0.01%. This is, of course, an ideal application where the temperature of the thermistor is nearly constant during its useful life. Glass coated, bead type thermistors were used at 500 deg C for a period of three months with less than a 0.1% change in resistance. After the three-months period, the units started to increase in resistance at the rate of about 2% a day and it is believed that this was because flaws had developed in the glass coating.

Another unusual use of a glass coated, bead type thermistor is for a fire detector in which the unit may be heated to 1,000 deg C for a very short time and then brought back to room temperature by 3 or 4% each time it is cycled, but this is of no particular importance, because it is not being used to make accurate temperature measurements at room temperature. A few percent error represents only 1 or 2 deg C and is unimportant in the application.

One company is using a glass coated, bead type thermistor as a temperature control sensing unit in the nozzle of a plastic extrusion press, where it is very important that constant temperature be maintained for several hours during the run of a certain plastic.

There are four major groups of uses for thermistors. **First:** those using the basic resistance-temperature characteristics (fig. 1) such as temperature measurement, temperature control and temperature compensation. **Second:** those using the voltage-current characteristics (fig. 2) such as voltage regulation, current regulation, power level control and volume limiting. **Third:** those using the current-time characteristics (fig. 3) such as time delay relays, integration of power pulses and memory in computer circuits. **Fourth:** those using various characteristics of thermistors in combination to measure some physical property (other than temperature) that can be converted into temperature by circuitry, such as gas analyzers, high frequency power meters, liquid level meters and pressure gauges.

In the first group, in which the resistance-temperature characteristic is used, there are a number of im-

Once just a laboratory curiosity, they are finding new applications

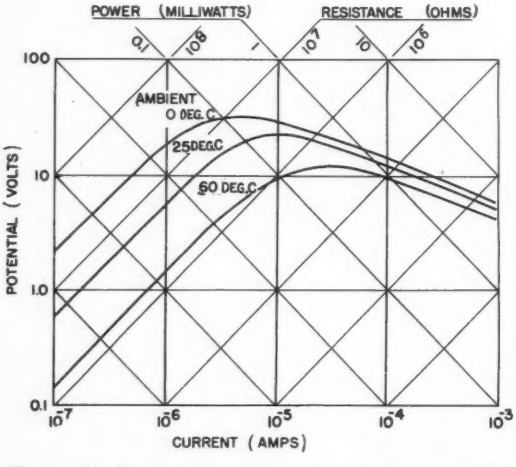


Figure 2. Steady-state voltage-current characteristics.

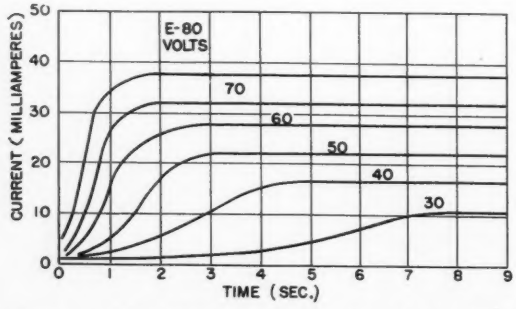
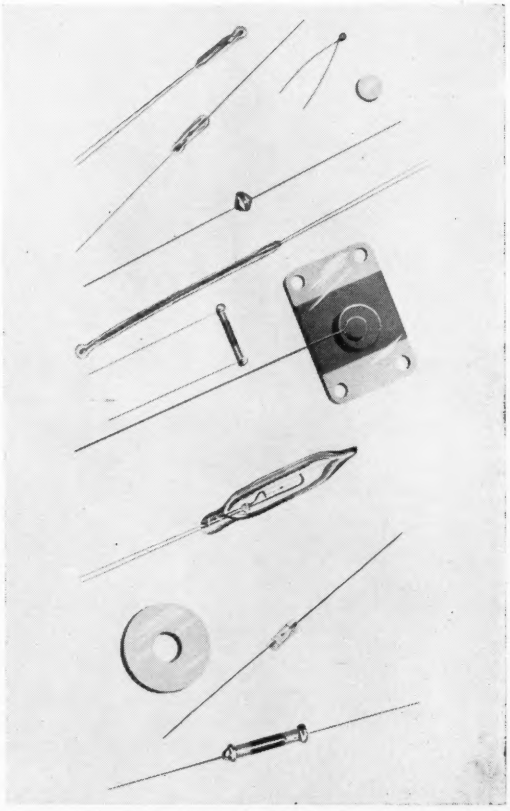


Figure 3. Time characteristic of a typical thermistor.



Some of the many shapes in which thermistors are made.

portant considerations which make thermistors better than other devices for measuring and controlling temperature. The resistance of a thermistor is a function of its absolute temperature and it is merely necessary to measure resistance to know the exact temperature of the thermistor, regardless of how it got there, whether by ambient temperature, self heat, indirect heater power or radiation. Since electrical power being dissipated within a thermistor might heat it above its ambient temperature and thereby reduce its resistance, it is necessary to test for resistance with a very small amount of power, so that there will be no measurable increase in the thermistor temperature. The resistance so measured is called R_o, which means the resistance at essentially zero power.

The mathematical expression relating resistance and absolute temperature of a thermistor is as follows:

$$\frac{R_o(T)}{R_o(T_o)} = e^{\beta\left(\frac{1}{T} - \frac{1}{T_o}\right)}$$

Where: $R_o(T)$ is the resistance at absolute temperature T, $R_o(T_o)$ is the resistance at absolute temperature T_o, β is a constant which depends on the material used to make the thermistor and e is 2.718.

Unless otherwise specified, all values of β are determined from measurements made at 0 deg C and 50 deg C. The value of β for Fenwal Electronics' thermistor materials is approximately 4,000.

The temperature coefficient of resistance "a" of a thermistor is expressed by the following equation:

$$a = \frac{1}{R_o}\frac{dR_o}{dT} \text{ ohms/ohm/deg C}$$

This is approximately equal to $-\beta/T^2$.

The value of "a" may also be expressed as a percentage per deg C and in some cases as high as —5.8% at room temperature, as compared to 0.36% for platinum.

Fig. 1 shows the resistance variation of two basic thermistor materials with temperature and also shows the resistance variation of platinum for comparison. Between the temperature of —100 deg C and 400 deg C, there is a change of ten million to one in resistance of thermistor materials, whereas platinum resistance changes by only ten to one over the same range.

Since thermistors can have high resistance values, it is possible to measure them with moderately high potential and low current circuits, thereby eliminating the necessity for heavy conductors and sensitive measuring equipment. No reference temperature is necessary (as it is with thermocouples), no special leads are required and wiring can be with any ordinary copper wire. Sensitive, low current instruments are not necessary and simple ohmmeters can do a fine job. If multiple circuits are desired, it is easy to switch from one thermistor to another with ordinary switches, because high voltages and low currents are used, instead of the low voltages and high currents of thermocouples. By using high resistance thermistors, remote measurements can be made without any special wiring, because the change in resistance of copper wire with ambient temperature is so small (compared with the value of the thermistor) that negligible error is introduced by such a transmission line. Vapor pressure and liquid expansion type instruments cause much trouble on long distance transmission because of their extreme sensitivity to ambient temperatures around the transmission line. Thermistors, therefore, when properly used, can give greater precision of measurement and control of temperature for less cost.

For temperature controls, thermistors are ideal because simple electrical or electronic circuits can be made to give great sensitivity and accuracy (fig. 4). Constant temperature baths can be controlled to 0.001 deg easily and to 0.0001 deg with a little more difficulty. Even finer control can be obtained but the equipment becomes quite complicated. It must be remembered, of course, that constant temperature baths to this precision require good design of the bath itself and that no control, no matter how sensitive, can make up for poor design of the controlled chamber or bath.

Small disc type thermistors are now being used in the windshields of aircraft to control the amount of heating applied to the glass to prevent frosting.

In the second group, in which the voltage-current characteristic of thermistors is used, there are many commercial applications now operating successfully. If the voltage-current curve of a bead type thermistor is plotted, it is found to show an increasing voltage with increasing current until a peak value is reached beyond which the voltage decreases as the current increases. In this particular portion of the curve, the thermistor is exhibiting a negative resistance characteristic. The slope of this portion of the curve represents the value of the negative resistance of the thermistor and if an ordinary resistor of the same value is placed in series with the thermistor, the net result of the two elements will be a curve of approximately zero slope over a broad range of current (fig. 5). This means that the network will have a constant voltage across it over a broad range of current and it will therefore be an excellent voltage regulator in an electronic circuit. It can be used in the same type of circuit as a gas discharge tube, but its operating range can be as much as ten times that of an ordinary gas tube. A gas tube operates normally over a current range of about 6 to 1, whereas a thermistor voltage regulator may operate over a range of about 60 to 1. Such voltage regulators have been used in voltage-regulated power rectifiers, where the thermistor network was used to supply a fixed reference voltage instead of a battery. This device was used in aircraft where it had to operate over a wide range of ambient temperature and batteries were not very stable under these conditions.

The third group

In the third group, using the time-resistance characteristics of thermistors, we find another telephone application. If we apply a fixed potential to a thermistor in series with a resistor, a small current will flow which will dissipate a small amount of heat in the thermistor. This will raise the temperature of the thermistor and thereby reduce its resistance, so that more current can flow in the circuit. This heats the thermistor more and lets still more current flow. The resistance of the thermistor keeps decreasing and the current keeps increasing until the voltage drop across the series resistance is increasing as fast as the voltage across the thermistor is decreasing. At this point the change ceases and the system is in equilibrium. The time required for the current to increase to its maximum value is a function of the resistance of the circuit, the voltage applied and the dissipation constant of the thermistor. If a relay is placed in series with a thermistor in this way, the current will reach a high enough value to close the relay at some time after the circuit is closed. This creates a controlled delay in the operation of the relay after the closing of the circuit (fig. 6).

Another interesting applicaton of time delay is in

Thermistors are made as rods, discs and washers or glass-coated beads

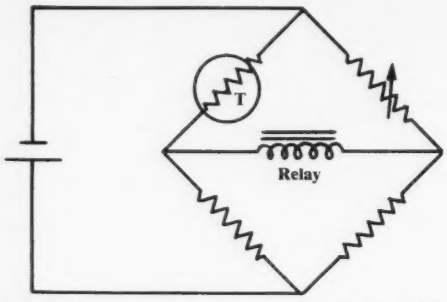


Fig. 4. Simple temperature control can be made by placing thermistor in series with relay, battery and variable resistor. Resistor adjustment will make relay operate at any thermistor temperature.

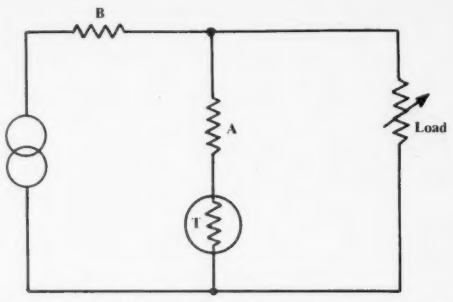


Fig. 5. Thermistor with a series resistor "A" may be put in parallel with the load to maintain constant voltage across it. As load resistance increases, drop across resistor "B" raises voltage across load.

Thermistors continued

oil burner control solenoids which open and close the oil line to the burner. In an ordinary oil burner system, the motor turns on and starts to turn slowly before it reaches full speed. During this time the blower is not going fast enough to produce any compressed air for the burner, but the oil pump starts to pump a small amount of oil which is not properly atomized and spills in the burner chamber. When the motor finally reaches full speed and the air is blowing at its proper velocity, an excess of oil has been pumped into the chamber and when the flame ignites, there is a small explosion and a puff of smoke due to incomplete combustion. This smoke makes frequent cleaning of the furnace necessary. By placing a solenoid valve in the oil line (with a thermistor in series with the solenoid) the motor has time to reach full speed and the air is blowing with full velocity in the burner before the solenoid finally operates and lets the oil spray into the combustion chamber. Since no oil has been spilled and there is a slight excess of air in the mixture, there is no explosion and no puff of smoke on ignition.

Consider now some of the commercial uses of thermistors in the fourth group. If two bead type thermistors are mounted in a bridge circuit and sufficient current is passed through them to raise their temperature to some value above ambient, like 120 deg C, and the necessary adjustments are made to make the bridge balance, this circuit can be used as the base of a number of instruments for measuring various physical phenomena.

If this same bridge is used with one thermistor mounted in a hole in a block of metal and the other one placed inside a pipe that has a gas (or a liquid) in it, the bridge can be balanced when there is no flow in the pipe. When flow is produced in the pipe, the greater speed of the fluid past the thermistor will take away heat faster and the thermistor will be cooled and the bridge will be unbalanced. Such an instrument can be calibrated in flow velocity or in flow volume. One nice feature of this type of flow meter is its **See page 64**

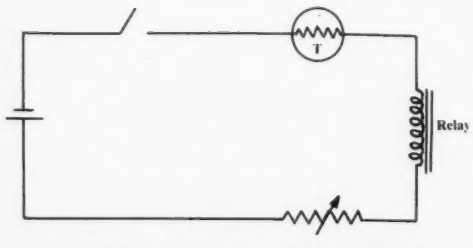


Fig. 6. A thermistor and variable resistor placed in series, as shown above, will make a variable time delay relay. As switch closes, the thermistor heats and releases current to close the relay.

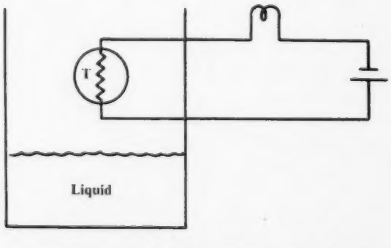
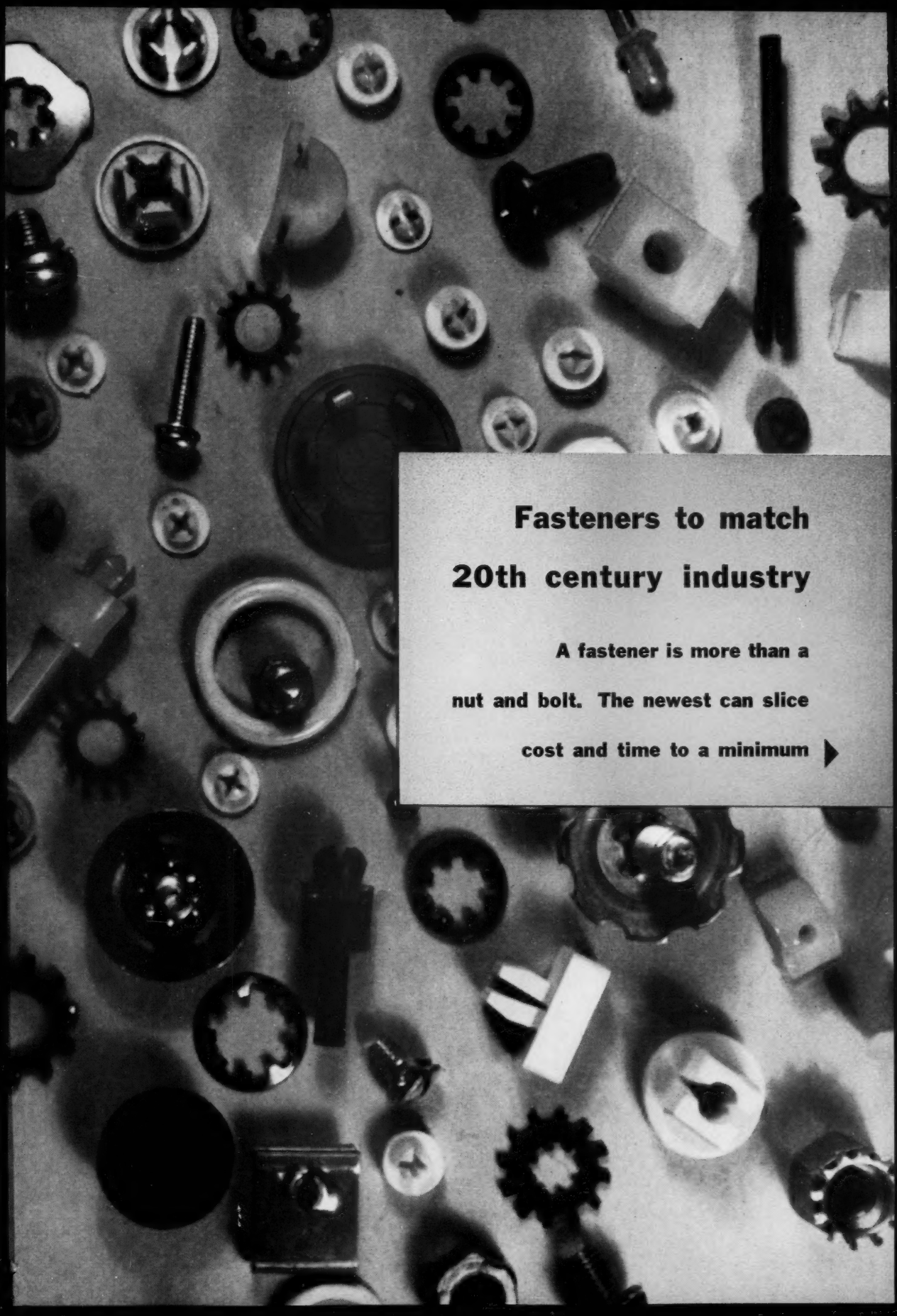


Fig. 7. With thermistor in series with battery and light bulb, the bulb lights if the thermistor is in air. Heating thermistor drops the resistance for enough current flow to light the light bulb.



Fasteners to match 20th century industry

A fastener is more than a nut and bolt. The newest can slice cost and time to a minimum

Modern fasteners are to the nail what rocket travel is to the horse and

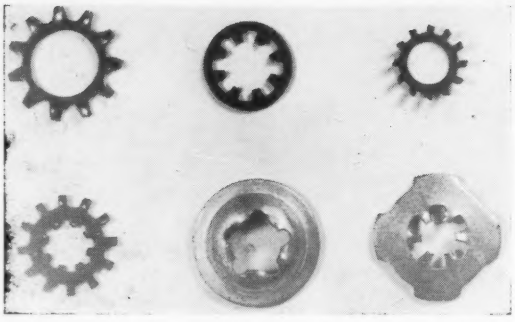


Fig. 2. Just a few of the many lockwashers available.

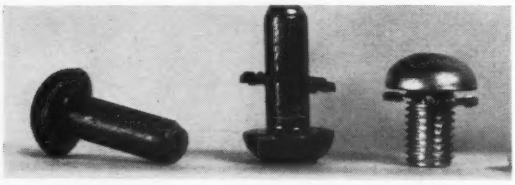


Fig. 3. A Sem — from the blank to a finished article.

By Fred Ballentine

The killing pace of present-day competition in industry has sent the harassed design engineer on a frantic search for improved manufacturing methods at reduced cost. One of the keys to production savings is the correct use of industrial fasteners.

In every product there are a number of places where simplified assembly and reduced cost can be attained by the use of modern fastening devices designed for the specific problem. Sometimes the resultant saving has a substantial effect on the cost, profit and selling price of the finished product. This article will high-light the more important trends in fasteners.

Smaller fasteners, fewer fasteners or a combination of these reductions can be used to provide lowered weight, more compact design, improved appearance and a positive lock at lower cost.

Lockwashers

A lockwasher which binds tighter with vibration is inexpensive insurance that the consumer will receive a product securely fastened. (Fig. 2)

Locking fasteners for tapped holes

Numerous devices are available for locking screw

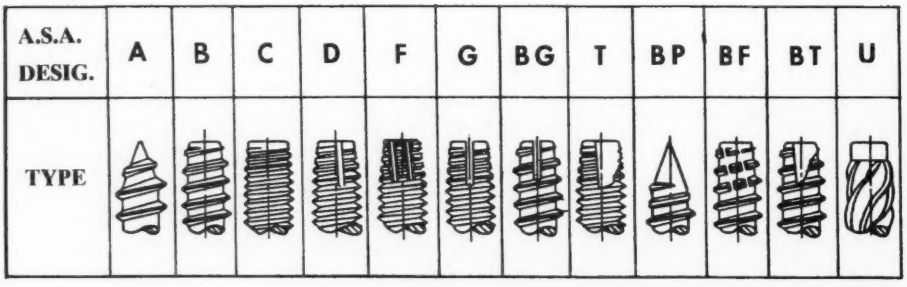


Fig. 7. There are three types of tapping screw. A more detailed explanation is found below.

What are the different types of tapping screw?

Types A, B and C are the thread forming types and are more suitable for thinner material (such as sheet metal) where the thickness is less than the pitch of the screw, allowing the thread to straddle the sheet. On thicker materials considerable resistance to driving results in excessive driving torques.

Thread-cutting types are more satisfactory for the heavier materials, particularly those with the sharper cutting edges like types D and T. Because the screw remains in the thread it has cut itself, there is perfect mating with no play between screw and work. This provides a stronger and tighter fastening than is ordinarily possible with machine screws in pre-tapped holes.

The types T and BT are particularly suited for softer materials (such as plastics and die cast metals) because of the large chip reservoir and the nature of these materials to pack.

Often sub-assemblies are painted before delivery to the assembly line. If attachment is made with a threaded fastener, the tapped hole may become clogged with paint which will interfere with the entry of the screw. To avoid the necessity of re-tapping the holes, a screw known as a paint scraper — Type F — is used. In this fastener the fluted entering end reams the paint from the tapped hole.

Type U drive screws are the outgrowth of tapping screws. They have an extremely fast lead which permits the screw to be pressed or hammered into place so that there is no necessity for torquing.

buggy. They have speed and efficiency

heads, the most familiar method being the use of toothed or split spring type washers. However, if assembly line workers have to pick up washers, push them into place and manipulate them while driving the screw home, there is a great loss of time and energy in fitting and fumbling. But Sems, as people in the trade know, are pre-assembled screw and washer units in which the screw thread is larger than the inner diameter of the washer, thus keeping the washer from falling off (Fig. 3). By this means only one part must be handled, speeding assembly.

Locking of screw heads is also accomplished by locking teeth incorporated in the screw head (Fig. 4). For certain applications similar results can be obtained by increasing the elasticity of fasteners by providing a slotted head (Fig. 4), which deflects under load and increases the over-all elasticity of the product.

The root interference lock screw (Fig. 5) is a standard screw with the exception that two of the threads have a root diameter slightly larger than the minor diameter of the tapped hole. When the section of the screw with the enlarged root diameter is screwed into the minor diameter it produces an interference fit which locks the screw firmly in place.

Screw heads

Convenience and ease of driving of screws may be accomplished by the use of specially shaped head recesses or sockets (Fig. 6). These sockets are fitted by mating drives. Recessed heads are usually more attractive than standard slotted screws and are adapted to rapid power driving.

Tapping screws

Another major trend from standard fasteners is the swing from machine screws and carefully tapped holes to tapping screws which make their own threads in drilled or punched holes. The savings in time and effort make them a must on the fast-moving assembly line. Being a one-piece fastener and requiring access to only one side of the work, they can be rapidly assembled and are replacing many stove bolt applications.

Tapping screws are divided into three classes: thread forming types, thread-cutting types and drive screws (see Fig. 7).

Locknuts

Where screws are used to hold the various components together, lockwashers or sems perform admirably. Where through bolts are used, locknuts provide outstanding service. A locknut, in addition to serving the purpose of an ordinary nut, has a special means of gripping a threaded member so that relative rotation between the nut and the threaded companion member is prevented. Locknuts may be classified as "prevailing torque" (Fig. 8) or "free spinning" (Fig. 9) and a variety of types, each with a different principle of locking, is available.

The prevailing torque types lock at any position on the bolt and the free spinning types assemble freely and lock after being torqued into position.

A group of special nuts are produced (not illustrated) which are designed to be rigidly prefixed to the workpiece by welding, clinching, pressing or staking. This saves considerable time in later assembly as

Do you know what these are for?

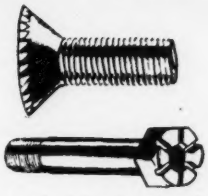


Fig. 4. A toothed head and a flexible head.

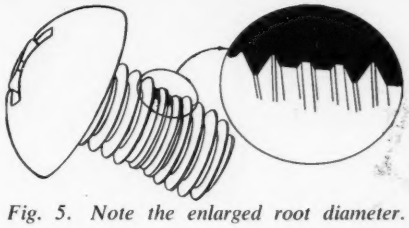


Fig. 5. Note the enlarged root diameter.

Fig. 6. Some of the special-shape recesses.

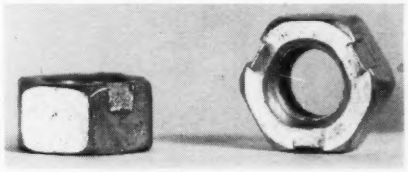


Fig. 8. A prevailing torque type locknut.

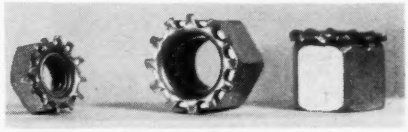


Fig. 9. Locknut of the free spinning type.

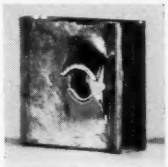


Fig. 10. A self retaining type speed nut.

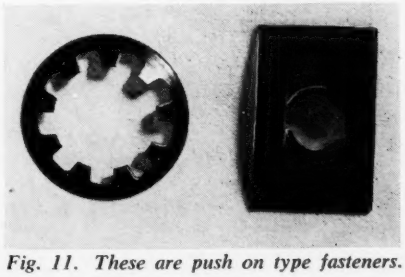


Fig. 11. These are push on type fasteners.

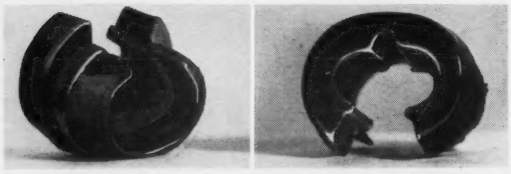


Fig. 12. The one piece nylon strain relief grommet.

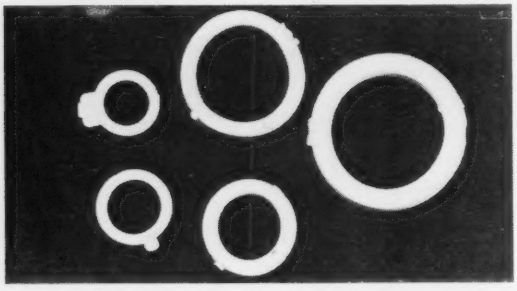
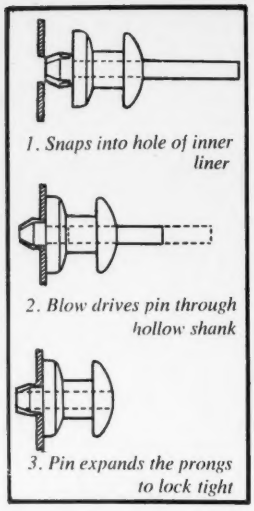


Fig. 13. Grease resistant shaft retainers in vinyl.



Figs. 14a and 14b. A support and the way it operates.

If it's a saving you're after, look to the fasteners in your product

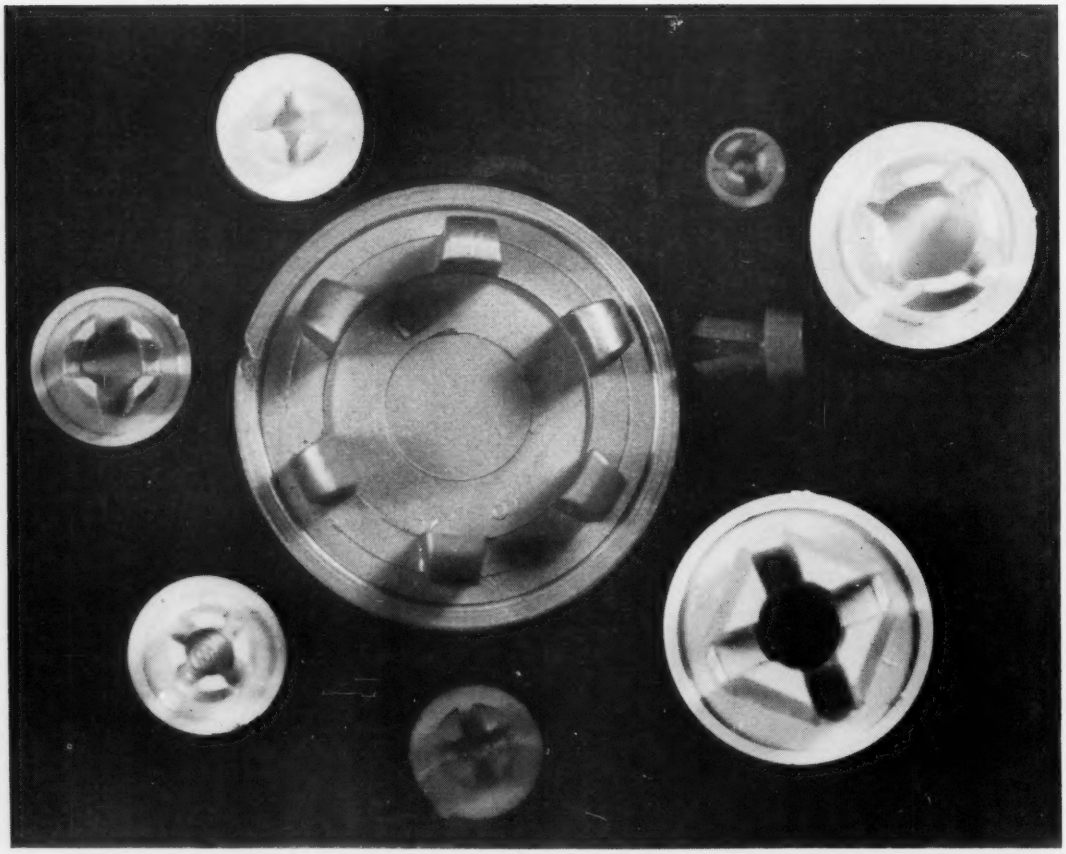


Fig. 15. Plastic plugs can be used in many ways. Appliance feet, drawer glides, hole fillers, just to mention a few.

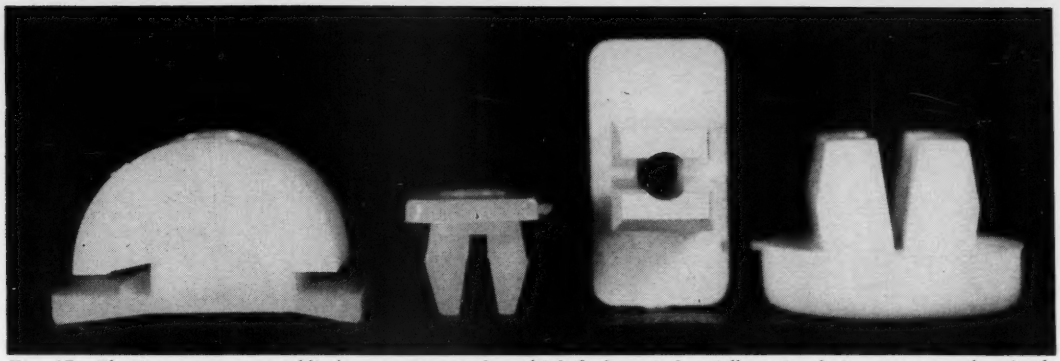


Fig. 17. Plastic grommets are blind screw receptacles which find use industrially as insulation spacers and so forth.

the workman can install the bolt blindly without the necessity of handling the nut. Cage nuts are a variety of the type of nut just described. The nuts are assembled somewhat loosely in a cage which is prefixed to the workpiece by welding, riveting or snapping into place. The advantage of the cage nut over the preceding group is that by reason of the nut floating in the cage it avoids alignment difficulties resulting from poor positioning of the fixed nut.

Self retaining type speed nuts (Fig. 10) hold themselves in screw receiving positions for blind location assembly.

Push on fasteners

Several varieties of fasteners are available which are designed to be simply pushed on a cylindrical pin without threads (Fig. 11). They push on easily but resist removal and where applicable save time since the fastener does not have to be screwed up in assembly.

Quick Release Fasteners

Several ingenious designs of quick release fasteners (not illustrated) are available. As the name implies, the fastener may be tightened or released quickly and easily, usually with a quarter turn of a screw driver. They are used primarily to fasten inspection doors, cowling removable panels, and other attachments that must be removed quickly and frequently.

Plastics

A steady increase in the use of plastics has introduced many new applications. Fasteners made of plastic are performing better at great savings in time and money. The strain relief grommet illustrated in Fig. 12 is one piece of nylon which eliminates groping for mating parts and speeds up assembly as well as providing positive protection to product wiring.

Rings of special oil and grease resistant vinyl are frequently used as shaft retainers. These rings (Fig. 13) roll over the end of the shaft into grooves and replace such items as cotter pins, nuts, split rings, coil wires and taper pins.

Shelf supports of plastic (Fig. 14a) are rugged one-piece fasteners for holding such things as trays used in the refrigeration industry. Fig. 14b shows how these

(continued on page 76)

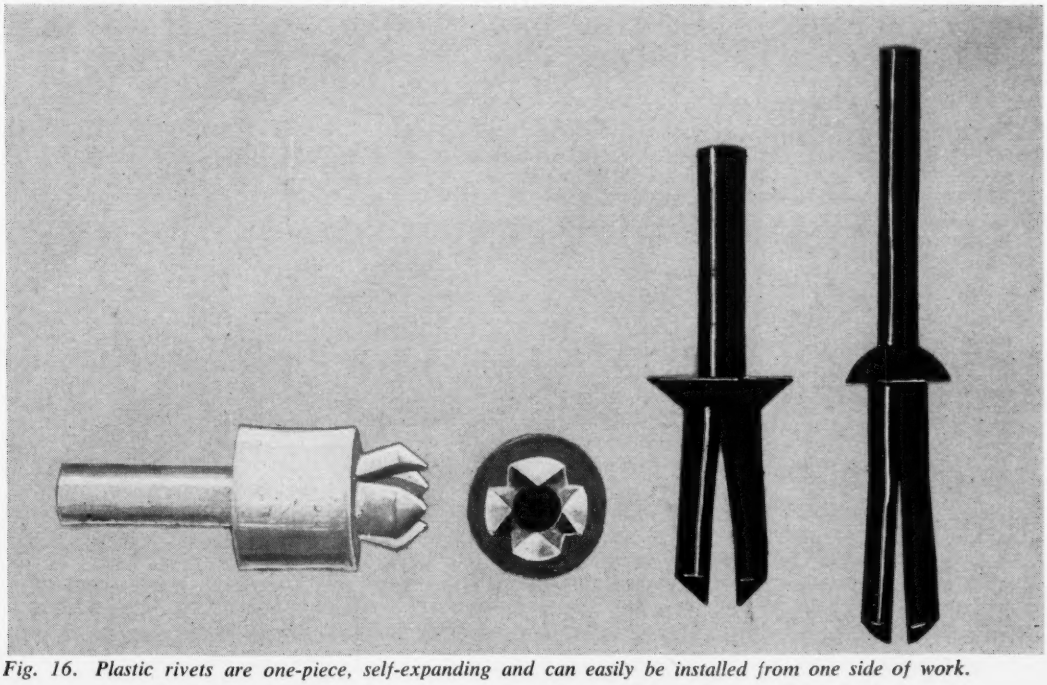
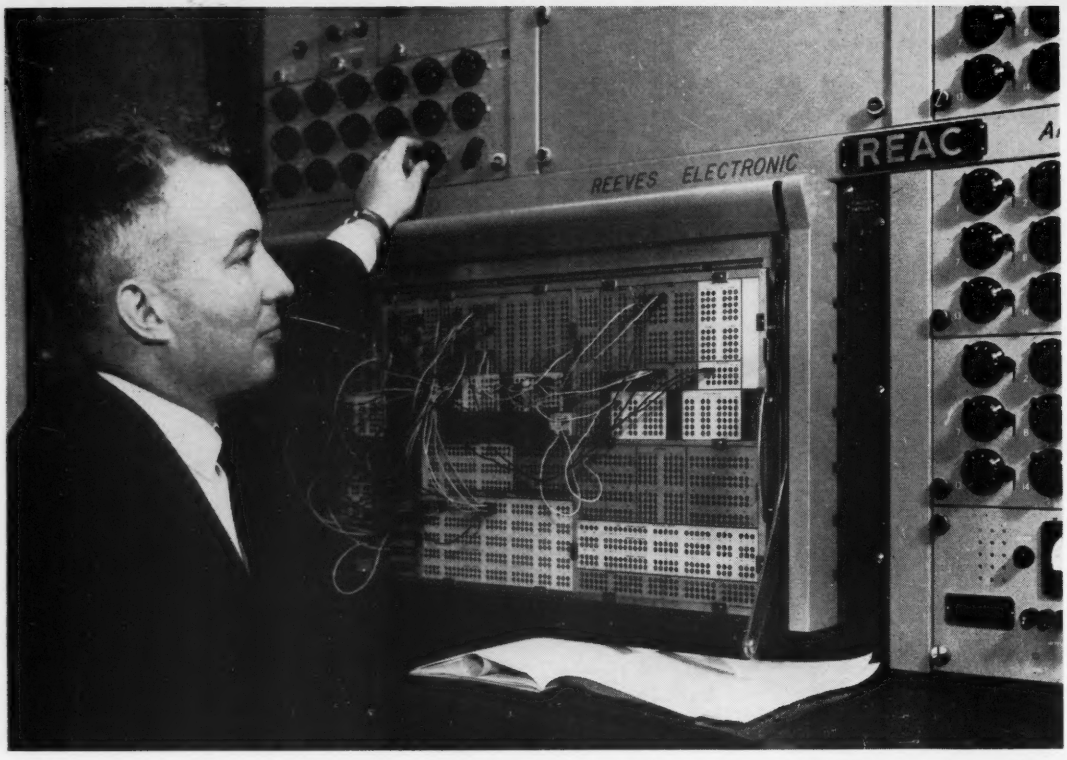


Fig. 16. Plastic rivets are one-piece, self-expanding and can easily be installed from one side of work.



REAC computer at the author's company is typical of modern analog computers for handling complex problems.

How does the analog computer do it?

Analog computers have become indispensable since they became available

Of the two types of computer, the digital and the analog, the digital can be looked upon as an automatic device which, by finite steps, is able to add, subtract, multiply, divide and carry out certain logic operations. Each and every mathematical expression must be reduced to the form of the simple operations before being fed into the machine.

On the other hand, the analog computer (with which this article is concerned) employs a continuous variable solution and not one by finite steps.

The very term analog implies a similarity (or analogy) of properties and the analog computer can therefore be set up to provide an analogous representation of the physical behavior.

In short, the analog computer is one in which electrical potentials are made to obey differential equations identical in form to those of the system under review. These electrical circuits perform such mathematical operations as addition, subtraction, multiplication and integration.

By D. F. Knudsen

An important new tool for the design engineer is the analog computer. To those who have had access to analog facilities it has become an indispensable aid in the 10 years or so since becoming available.

The analog computer has been compared with the slide rule. This is true in the sense that the slide rule is a primitive analog device. But the modern analog computer is as far beyond the slide rule as the digital computer is beyond the abacus.

The analog computer calculates by measuring. The things it measures and compares are electrical voltages, mechanical angles and positions.

Individual components must meet extremely rigid standards for accuracy and reliability if the machine is to have a reasonable degree of precision. These components include amplifiers, diode function generators, limiters, computing resistors and condensers, servos, relays, switches, potentiometers, recorders, curve followers and plotters.

The amplifiers are the most important components. A large computer may have upward of 100 of these amplifiers, all identical. They are used for adding, subtracting and integrating. In a typical modern computer,

such as the REAC, they are a high gain (about 10^5) d-c broadband amplifier, stabilized with a 60-cycle chopper-type a-c amplifier to give a total gain of 10^8. They are designed with an odd number of stages so that a sign change is introduced between input and output to permit the use of negative feedback.

Fig. 1 shows the basic circuit diagram of the operational amplifiers. If we assume that the gain of the amplifier is very large, it can be shown that the ratio of E out to E in is equal to the ratio of $-Z_f$ to Z_{in}. Similarly, if a number of input impedances are connected in parallel, it can be shown that the output voltage is proportional to the sum of all the input voltages. Thus we are able to add.

If Z_f is replaced by a condenser, the output voltage is proportional to the time integral of E_{in}, with the constants determined by the value of the components.

Thus addition and integration can be accomplished relatively easily. There are several ways of performing multiplications, all of them more complicated than those discussed so far. One way is to use a servo, an electromechanical device which rotates a potentiometer shaft by an amount accurately proportioned to an input voltage signal. In the simplest case, the servo can be used for multiplication. For example, if a potentiometer is excited with X volts and the servo rotates the slider to Y% of full scale, the output at the slider under no load conditions is XY/100 volts.

With a number of components that can add, multiply and integrate, we merely need to connect them together in the right way in order to solve differential equations.

Take an equation like:

$$\frac{d^3x}{dt^3} + x^2\frac{d^2x}{dt^2} + 10 = 0$$

This can be rearranged as follows:

$$-\frac{d^3x}{dt^3} + \frac{x^2\, d^2x}{dt^2} + 10 = 0$$

Assume we have a signal which is equal to the third derivative of x. (Never mind the fact that we haven't got it yet.) Integrate this signal three times to get x. Multiply x by itself to get x^2, take the output of the first integrator (which is $\frac{d^2x}{dt^2}$), multiply it by x^2, and add 10. The result is the signal we started with, and all we have to do is feed the output back into the input of the computer and the setup is complete.

Fig. 2 shows a block diagram of the computer elements connected for this problem. The values of the condensers and resistors are chosen so that the integration takes a convenient period of time (usually about 30 sec) to complete. Simply take a tap from a point in the circuit representing x and feed the voltage into an oscillograph. The result is a curve representing the variation of x with time, from which numerical values can be taken as needed.

This is a simple example. The only limit to the complexity of the equation that can be solved is the number of components in the computer that can be connected together.

For the above example we have used five amplifiers and two servos. In a large computer there may be as many as 100 amplifiers. The REAC used by Computing Devices of Canada Ltd. has 20 integrators, 36 summers and 40 invertors, and has 14 servos for multiplication and other uses.

The analog computer, like almost all tools, has some

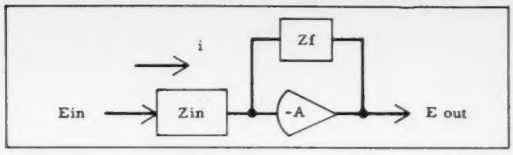


Figure 1

limitations. It can be used to solve ordinary differential equations (with or without constant coefficients) but it is helpless when confronted by a partial differential equation. Also, in its operation, time must be chosen as one of the variables. This does not mean that time must be a variable in the physical system from which the equation came, but it does mean that time must be taken as the analog of the independent variable in the problem.

This ability to solve differential equations gives the electronic analog computer widespread application in many engineering fields. Almost all circuit design problems reduce to ordinary differential equations, extremely tedious to solve by manual methods, but easily handled on an electronic analog computer.

The analysis of dynamic systems is another class of problem that lends itself to computer solution. Everything from the study of a simple suspension system for a vehicle to the behavior of a guided missile falls into this category. The aircraft industry makes extensive use of analog computer facilities to investigate problems in vibration and flutter, control systems and aerodynamics.

Fields of usefulness for analog computers are still being discovered. The first and obvious use is in exploring the behavior of dynamic systems. In many cases, there would be no way for an observer to tell from the connections on the computer whether it was set up to solve an electronic problem or a mechanical one. To the machine, a tuned circuit in electronics is exactly the same thing as a vibrating spring and weight. The differential equations have the same form.

Sometimes, in a complex dynamic system, it may be desirable to include parts of the actual physical system in the computer. This happens when it is difficult to simulate the output of a part of the system, and that part is available and portable. The prime example of this is when part of the system is a human operator.

Another occasion arises when one wishes to test the performance of a subsystem which is being designed without using the system in which it will be used. For instance, the computer may be set up to behave like an engine and used to test the effectiveness of a speed control.

Suppose the computer is set up to study the control system of an aircraft. The pilot is an essential part of this system, and it is far easier to use his reactions directly than it is to simulate them with computer components. **(continued on page 79)**

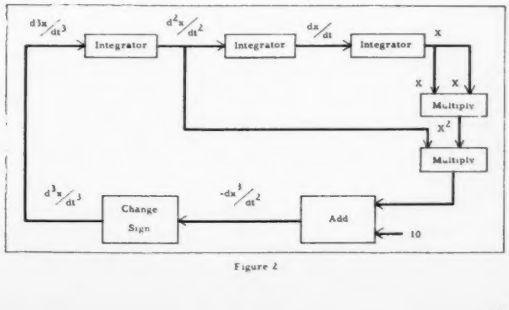


Figure 2

Steelmakers use high-purity oxygen

The arrival of high-purity oxygen has started a new way of steelmaking

How did modern steelmaking start?

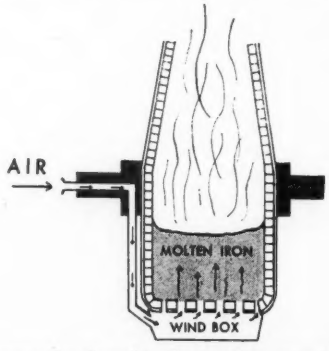
Very little steel was produced in the days before 1856, when Henry Bessemer developed his converter. This device resembled a large cauldron with a series of holes (called tuyeres) in its base (see figure). Air was blown through these tuyeres and up through a bath of molten iron, thereby converting the iron into steel. The phosphorus, sulphur and nitrogen content of Bessemer steel was high and this resulted in a brittle steel with limited uses because its ductility was poor. The Thomas process (of 1879) changed the acid type method to basic and helped to remove some of the phosphorus and sulphur. This improved the steel somewhat and made it more resistant to impact. Still it contained a large amount of nitrogen and its ductility was poor.

Close on the heels of the Bessemer converter came the open hearth furnace, introduced by William Siemens in 1862. Not unlike the original puddling furnace, it also consisted of a hearth to contain the iron (see figure). Over this, heated air and intense flame were passed, which melted the iron and slowly converted it into steel. Great heat was obtained through regeneration, whereby heat from the flame was directed into a chamber before being released up the stack. This chamber, in turn, preheated the fuel and blast air. Although relatively slow in operation, this furnace allowed the control of temperature and slag and resulted in steel containing low percentages of phosphorus and sulphur, and much less nitrogen. With less nitrogen, a better grade of steel could be produced, since it was more ductile.

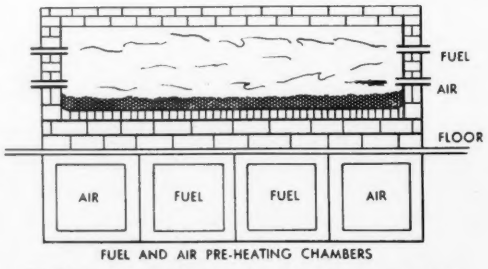
Open hearth steel can be drawn and formed and can be easily alloyed with other metals, either in the furnace while being produced or by remelting later. Much scrap can be used, varying in amount from 100% down to a minimum of 40%. From the 1,500 tons produced in open hearths in 1870, its production climbed rapidly, until today 90% of the world's steel comes from modern open hearth furnaces.

Several years ago it was discovered that a high quality of steel can be produced very rapidly by impinging a jet of high-purity oxygen on the surface of molten iron. Recently a commercial method of producing high-purity oxygen in quantity was discovered. This led to the development of the revolutionary new oxygen steel-making process.

Exhaustive metallurgical tests show that the new oxygen steel is of the highest quality obtainable today, and for certain difficult applications it is definitely superior. With a low 20% scrap addition, the amount of tramp elements is very low, resulting in a more virgin metal, with nitrogen very low.



Converter developed by Henry Bessemer in 1856.



William Siemens' open hearth furnace of 1862.

"Teeming" or pouring a heat of oxygen steel. This 50-ton ladle operates on the bottom pouring principle.

The process allows rigid control of temperature and quality in steel

In pioneering the new oxygen process of steel making on this continent Dominion Foundries & Steel Limited (of Hamilton, Ontario) reached the decision only after being convinced that this new steel would be of higher quality than that made in any existing large-tonnage process. This revolutionary method of making high-quality steel has been made possible by two recent developments: a technique for the use of pure oxygen in the conversion of blast-furnace molten iron into refined steel, and the perfection of equipment to produce cheap, high-purity oxygen on a tonnage basis.

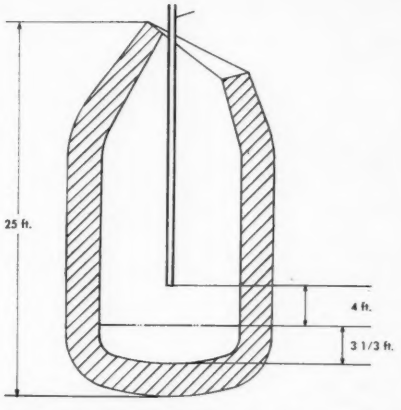
The use of oxygen in one form or another has been an essential part of steel-making processes ever since the art of steel making was first developed. The Bessemer and Thomas processes use an air blast to provide oxygen to oxidize the unwanted elements in the charge. Unfortunately the nitrogen introduced with the oxygen in the air blast is picked up by the steel, and the end use of the steel is limited by the strain-ageing effect of the retained nitrogen.

The use of pure oxygen in the conversion of iron to steel has been an obvious goal for researchers. The process has combined the high-production rhythm of the Bessemer process with the high quality of the open-hearth process, while at the same time eliminating many of their inherent disadvantages.

In the process, a stream of high-purity oxygen is directed onto the top surface of the bath. The vessel used is pear shaped (see figure).

The oxygen pressure used is about 150 psi but may vary from this to some degree. The oxygen stream leaves the nozzle in the form of a cone at a velocity greater than the speed of sound and, on striking the bath surface, produces a reaction area or "hot spot." The reaction of oxygen with the bath is instantaneous at this point and, by test, is highly efficient from the point of view of oxygen usage, which is about 105% of that theoretically required to oxidize the oxidizable elements in the hot metal.

The effect of the oxygen striking the bath is to produce iron oxide, part of which immediately fluxes the lime portion of the charge, forming a basic slag like that produced in an open hearth.



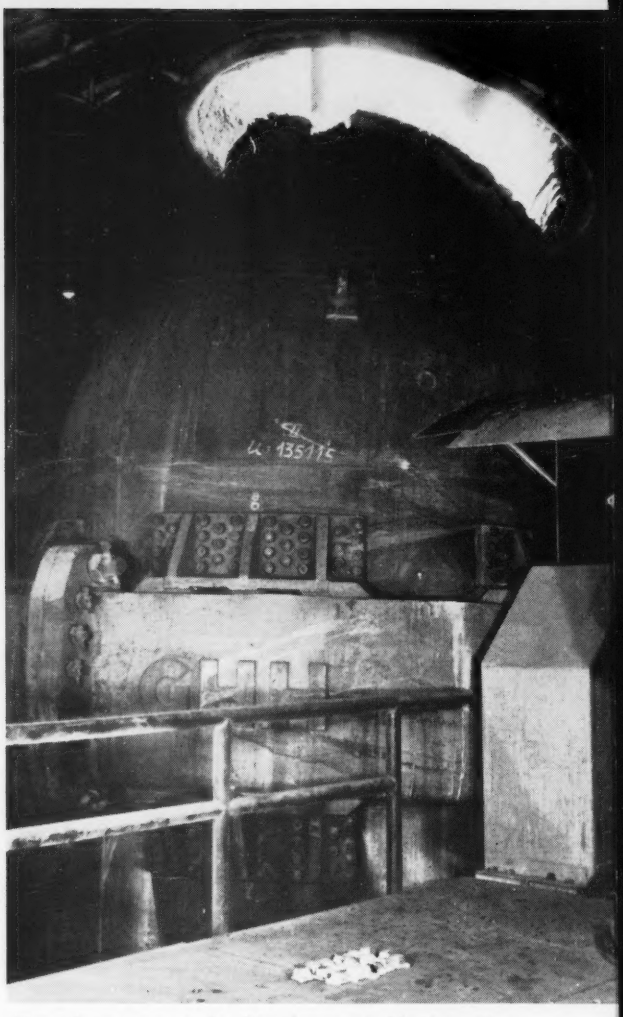
The pear shaped vessel which is used for the oxygen steel process. Note the lance.

It is in this early formation of a basic refining slag that there is a major difference between the oxygen process and the Thomas converter process. In the latter, the lime flux is not melted until after the carbon is eliminated and only then can the phosphorus be taken up by the slag. In the oxygen process, most of the phosphorus (and sulphur) elimination has been accomplished when the mid-point of the cycle is reached.

The remaining iron oxide formed would appear to enter and diffuse in the bath, where it combines with the major oxidizable elements (Si, Mn and C) which actually serve as deoxidizers.

The percentage of the residual elements in the steel at the end of the treatment can be controlled within

In this picture a giant stripper crane can be seen as it removes a mold from the 5-ton oxygen steel ingot.



Here the oxygen steelmaking furnace is blowing. Note the oxygen lance almost hidden in flames above bath.

"The newest oxygen steels are of the highest quality obtainable today"

Oxygen steels continued

fairly close limits. Carbon will range from 0.03 to 0.05%; manganese will vary, depending on the manganese in the charge and on the slag composition and volume. When using a basic type hot metal with, say, 1.25 Mn, the residual manganese will be within a range of approximately 0.20 to 0.25%. This is a much higher residual than is found in open-hearth steel, and the presence of this high residual manganese has a distinct advantage in ensuring against overoxidization of the steel, Lower residual manganese contents can be achieved if desired by using a two-slag practice.

The nitrogen content is primarily dependent on the purity of the oxygen used. Experience indicates that, in order to keep it in line with the low residual nitrogen achieved in the open-hearth furnace, the oxygen purity must be 99% or more. The Dofasco oxygen steel plant has an oxygen plant capable of producing 99.5% pure oxygen.

The charging of scrap, hot metal and fluxing material is relatively simple. The scrap is charged first from an open-end charge box suspended from a crane. The scrap may be of any size which could be charged to an open hearth. The hot metal is charged immediately after the scrap, using a long-nosed hot-metal-type transfer ladle.

The vessel is then brought to the operating position, the lance is lowered into position and the oxygen turned on. The reaction starts immediately and approximately two thirds of the lime charge is added at this time. A small quantity of mill scale, ore (or some other flux), may also be added at this time to aid quick fluxing. ★

Anodizing gives protection and glamour

A long known process that has recently shown some rapid developments

By I. H. Jenks

The first reference to the production of an oxide film on aluminum occurred almost 100 years ago, but it was not until 1924 that a process was patented for anodic films on a commercial basis. This process used a chromic acid electrolyte to produce a coating for protecting the metal when exposed to a corrosive environment. Four years later, a method was patented using a solution of sulphuric acid to produce thick anodic oxide coatings. Since then, there have been so many developments in anodizing aluminum that it has become the most important commercial treatment of this nature. In present commercial practice, aluminum alloys are being anodized in such solutions as sulphuric acid, phosphoric acid, chromic acid and boric acid.

Some of the commonly used anodizing processes are shown in the table, together with some of the characteristics of the films produced by each and typical applications for which they are suitable. As far as Canada and the U. S. are concerned, the sulphuric acid and chromic acid processes are used almost exclusively, with the former by far the more important.

The anodic film produced by the sulphuric acid process (Alumilite) is hard and transparent and is thus particularly recommended for articles where good abrasion resistance or decorative effect is important. The metal under the anodic film retains its original metallic lustre (except in the case of some alloys, where certain alloying ingredients impart a characteristic color). The sulphuric acid films are clearer and thicker than those produced in chromic acid and, because of the low cost of the electrolyte, are cheaper to produce. On removal from the anodizing bath the film is porous, but immersion in boiling water (and some other substances) seals the pores and gives maximum protective properties to the film.

It so happens that the porous nature of the initial film is the basis of color anodizing. The porous film, when dipped in an aqueous bath of dye before sealing, takes up the color and subsequent immersion in boiling water seals the dye on (and in) the anodic layer. Color anodizing has become an outstanding finishing treatment for aluminum and has contributed greatly to the wide variety of its uses.

While the chromic acid film is not as hard as the sulphuric acid film, it imparts a high degree of protection to the base material. Because the electrolyte is inert, the treatment can be applied to assemblies which are porous in nature and have crevices in them. It is used most widely in protecting aircraft parts. The chromic acid film is grey and opaque and will take dyes in the same way as sulphuric acid films. Sealing may be done in boiling water but is generally omitted.

In addition to the properties mentioned above, anodizing confers on aluminum a much greater resistance to corrosive conditions since it increases the thickness of the metal oxide film by about 1,000 times. Still another very useful characteristic of anodic films on aluminum: the good insulating properties, so particularly useful in electrical applications.

All anodic oxidation treatments are basically the

The most recent and significant advances in anodizing

The process of anodizing (anodic oxidation) is an electrolytic one for applying a protective or decorative coating to the surface of aluminum and aluminum alloys.

Possibly the chief development on the process side has been the establishment commercially of the method known as "Hard anodizing" wherein certain anodizing variables are modified to produce coatings that are sufficiently hard to resist marking by a medium-cut steel file. Hard anodizing processes employ high current densities (50 to 350 amp/ sq ft) and an electrolyte temperature in the region of 32 deg F. Vigorous agitation is required.

The availability of high purity aluminum has stimulated interest in "Bright anodizing." This development demands a correct combination of aluminum alloy, brightening process and anodizing conditions, in order that a range of bright finishes comparable to chromium plate may be obtained.

Another significant development, indicative of the rising industrial status of anodizing, has been the installation of plants to do automatic anodizing. Great Britain and the U. S. have pioneered in these installations.

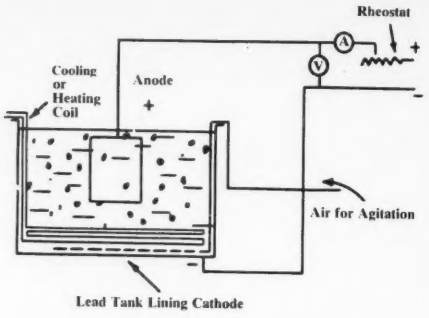
A complement to the automatic anodizing of components is the production of strip and wire by continuous anodizing methods. Recently, the Aluminum Company of Canada, Limited announced the development of a continuous anodizing method of producing wire suitable for several high-volume electrical applications. The Monarch Weather Stripping Corporation of St. Louis has described the main features of a continuous plant built to handle strip of suitable dimensions for can making.

These, and many other developments, have been brought forward in recent years and have been responsible for the increasing use of the anodizing process on a commercial basis.

Anodic processes for aluminum and its alloys

Electrolyte Acid type	Voltage	Film type	Film thickness (mils)	Application
Boric	50-500	Non-porous	0.01	Electrical insulation
Sulphuric	15-20	Porous	0.1-1.0	Clear, colored, corrosion, prepaint
Chromic	30-60		0.1	Prepaint, corrosion
Oxalic	60		0.1-1.0	Clear, colored, wear
Sulphuric	20-100	Hard	0.5-3.0	Wear

Note: 1 mil 0.001 in.



same and vary only in equipment and operating details. The aluminum is made the anode (positive electrode) in a bath of electrolyte (Fig. 1) and an electric current passed between the anode and the cathode (negative electrode) with the formation of an aluminum oxide layer. The lining of the anodizing bath may serve as the cathode and the anode or work piece is immersed in the solution. Agitation is advantageous and is normally provided by bubbling air through a perforated pipe. Temperature regulation is necessary and so the anodizing tank contains a coil for heating or cooling the fluid. It is possible to use alternating current, but since oxidation proceeds only in that part of the current cycle when the metal is the anode, the efficiency is poor, and hence direct current is usually employed.

Common features

All the processes have certain features in common, such as: proper preparation of the surface to be anodized, racking, methods for stripping faulty anodic films and sealing procedures. Chemical cleaning prior to anodizing is generally required to remove grease or lubricants acquired by the work piece during fabrication. The solutions used may be alkaline or acidic in nature. A chemical brightening (or bright dip) treatment after cleaning will produce a bright, clean surface which will lose a smaller degree of its brightness on anodizing than will a mechanically polished surface. This is especially effective on work which is intended for dyeing. In cases where a high degree of brightness is required (as in reflectors), the surface may be electrolytically polished with the work as anode in an electrolytic brightening bath. Mechanical polishing is required in conjunction with this treatment.

In anodizing, it is essential for the work to be secured rigidly in racks, jigs or other holding devices used to immerse the object in the anodizing bath. Since these racks carry the current to the work-piece, mechanically rigid, wired, screwed or spring-loaded mechanisms are used for most work. Small parts (such as rivets and screws) may be anodized in perforated baskets. The rack design depends largely on the shape and size of the article and the number of pieces to be treated. The racks must be made of aluminum alloy to avoid contamination of the bath and minimize current consumption. During treatment, the surface of the rack becomes anodically coated along with the parts to be treated. This coating must be stripped from the points of contact by mechanical or chemical means prior to a second use of the racks.

The actual anodizing step involves suspension of the work in the bath by hooks, which make contact with the bus bars along the top of the anodizing tank, where it is left under the appropriate operating conditions for the proper length of time. The optimum anodizing conditions will vary according to the type and thickness of film required. The variable factors are: the acid concentration, bath temperature, current density, time of immersion and degree of agitation. Generally speaking, high acid concentration will produce a softer and thinner coating and lower the voltage necessary for a certain current density. Higher electrolyte temperature increases the dissolving power of the bath and decreases the film thickness, lowers the voltage required to produce a certain current density and increases the film porosity. Increased current density produces an increased coating thickness and a decreased film porosity.

The length of treatment is one of the major factors determining the depth of coating obtained. The thickness of the film is limited by the fact that while it is growing, chemical solution of the oxide film by the electrolyte takes place simultaneously, until eventually an equilibrium point is reached. At this point the rates of electrochemical formation and dissolution are equal and no further increase in film thickness can be secured by continued treatment under the same conditions. The thickness of the anodic film can be varied within wide limits by choice of the proper anodizing conditions. Thin hard films or thick porous ones may be produced according to requirements. The anodic coating is porous as it leaves the bath (and hence easily stained), but sealing renders the coating impermeable and nonabsorptive. The sealing process most widely used is a treatment with hot (or gently boiling) water for about the same time.

A variety of colored coatings can be produced on anodized aluminum by dyeing the films with inorganic or organic dyes. With inorganic dyes, certain pigments may be precipitated within the pores of newly formed oxide coatings. Thicker anodic coatings are recommended since they give better results with inorganic pigments. The range of colors is limited and the results less brilliant than with organic dyes. The aluminum surface is first anodized, usually by the sulphuric acid process. After anodizing, the surface is rinsed with cold water only, treated successively **(continued on page 80)**

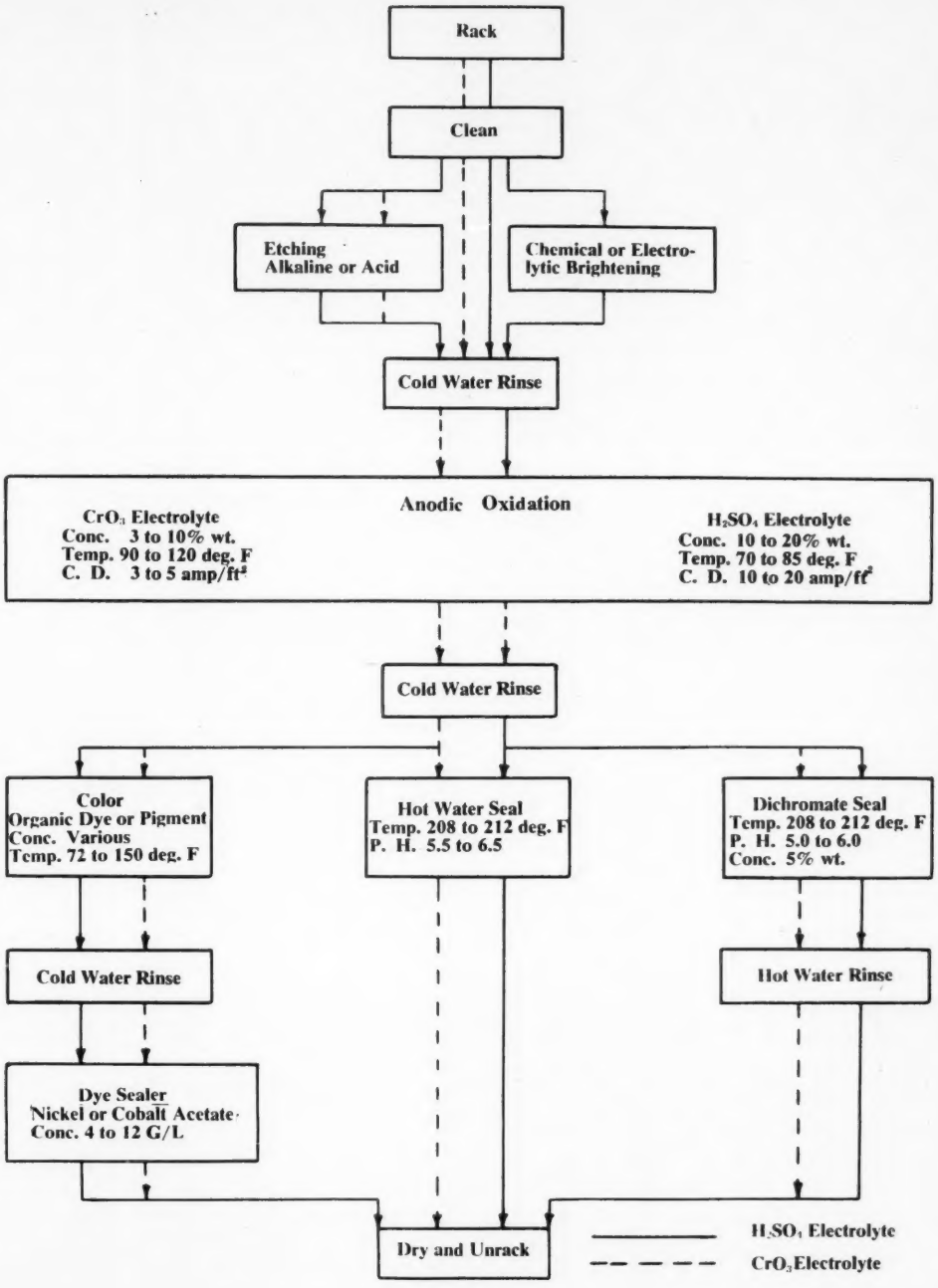
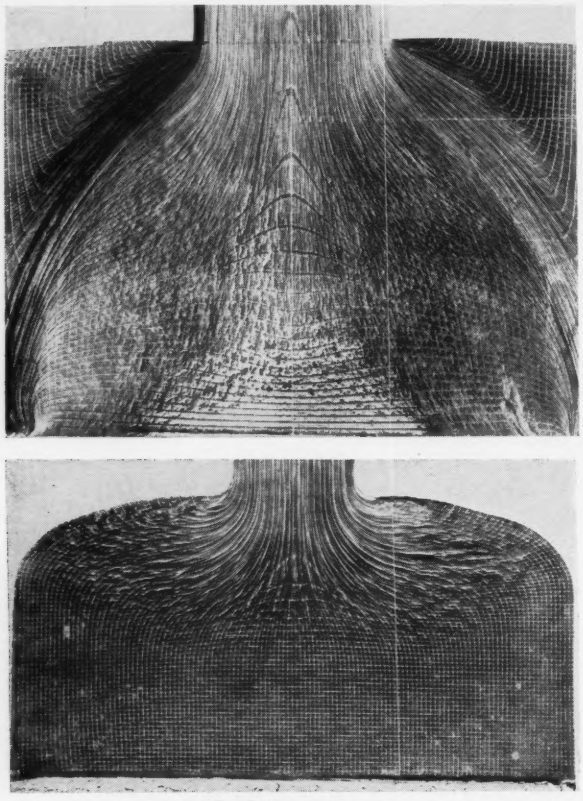


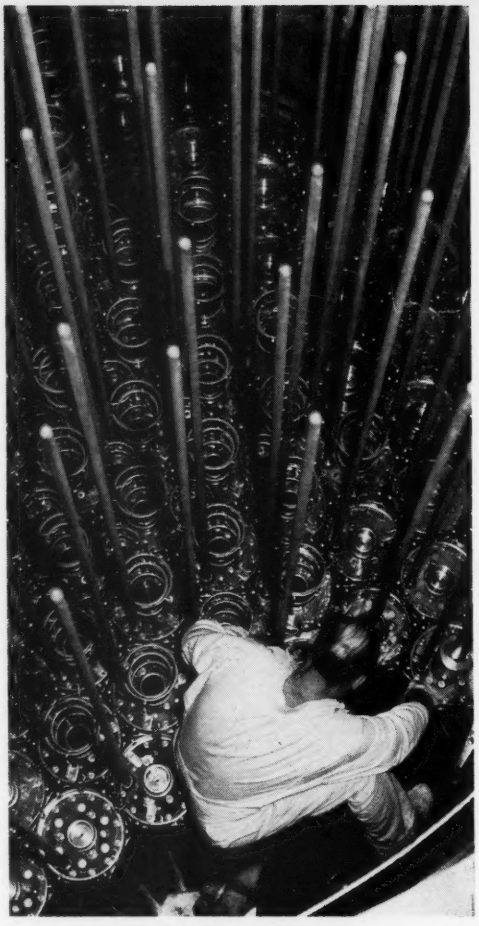
Fig. 2. The sequence of operations and general operating details are summarized in this flow-sheet by Vanden Berg. Mr. Vanden Berg is a leading authority in the anodizing field.

Design news in pictures



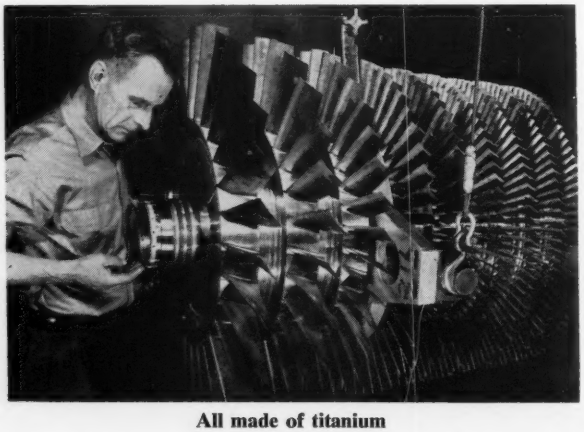
Metal flow patterns

The difference in metal flow in lubricated (lower) and unlubricated (upper) extrusions is shown here. These photographs are from the Journal of the Royal Aeronautical Society and the authors, G. Forrest and K. Gunn, say there are drawbacks. (200)



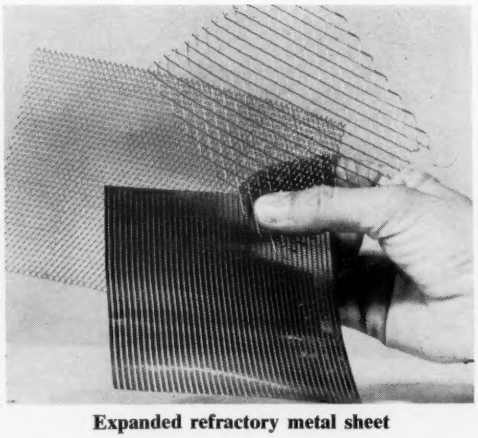
Peek into a reactor core

The camera looks into the core of a nuclear power plant built by Atomics International. The moderator cans contain graphite for controlling the neutrons which will cause atomic fission. (201)



All made of titanium

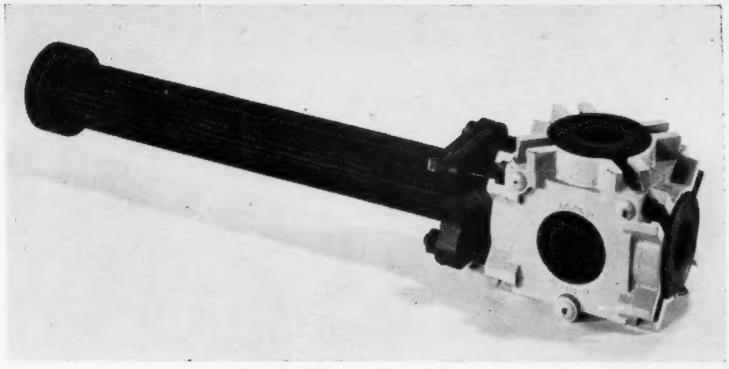
This all-titanium J-57 compressor rotor is now in production by Pratt and Whitney for advanced high-speed jet airplanes. Titanium blades and discs, as well as other titanium jet engine components, have shown outstanding flight performance. (202)



Expanded refractory metal sheet

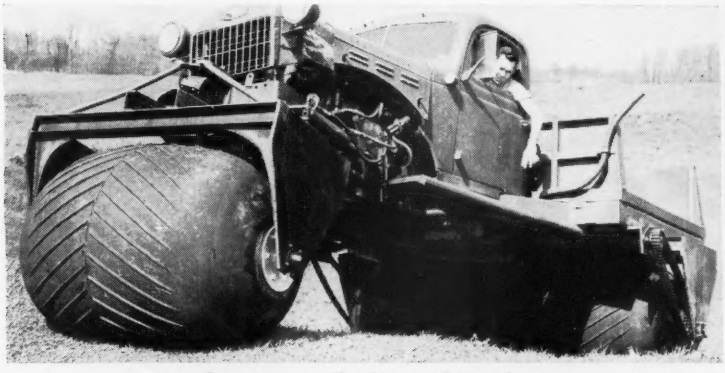
These are examples of tantalum and molybdenum expanded metal. These can be produced in a variety of sheet, thickness and opening sizes. The characteristics of these metals suggest many uses. (203)

Some modern designs making news today



Armored pipe for corrosives

A strong glass fabric bonded to "Karbate" impervious carbon pipe not only armours and strengthens this pipe but, in case of breakage, it remains intact, holding line pressure and preventing gross leakage. Connections are made through a metal housing which isolates the fitting from stresses. (204)

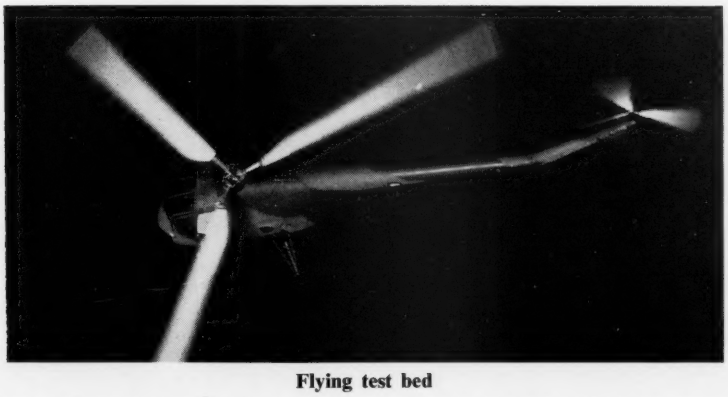


Low-pressure tire for rough terrain

This vehicle is riding on Terra-Tires, low-pressure pneumatic tires that can be powered through their axles by any conventional drive system. The tires, made by Goodyear, are free of the weight and mechanical complications that burdened previous types. Speeds up to 65 mph are possible. (205)

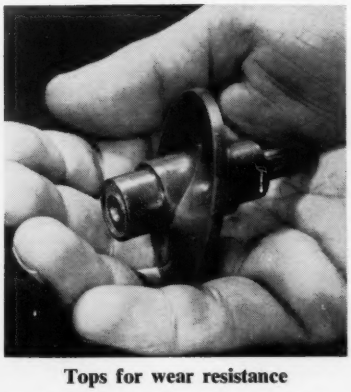
One-man TV station

This is the 4-lb. TV camera and 15-lb. pack transmitter developed by RCA's scientists. It is designed for spot coverage to transmit a mile. (206)



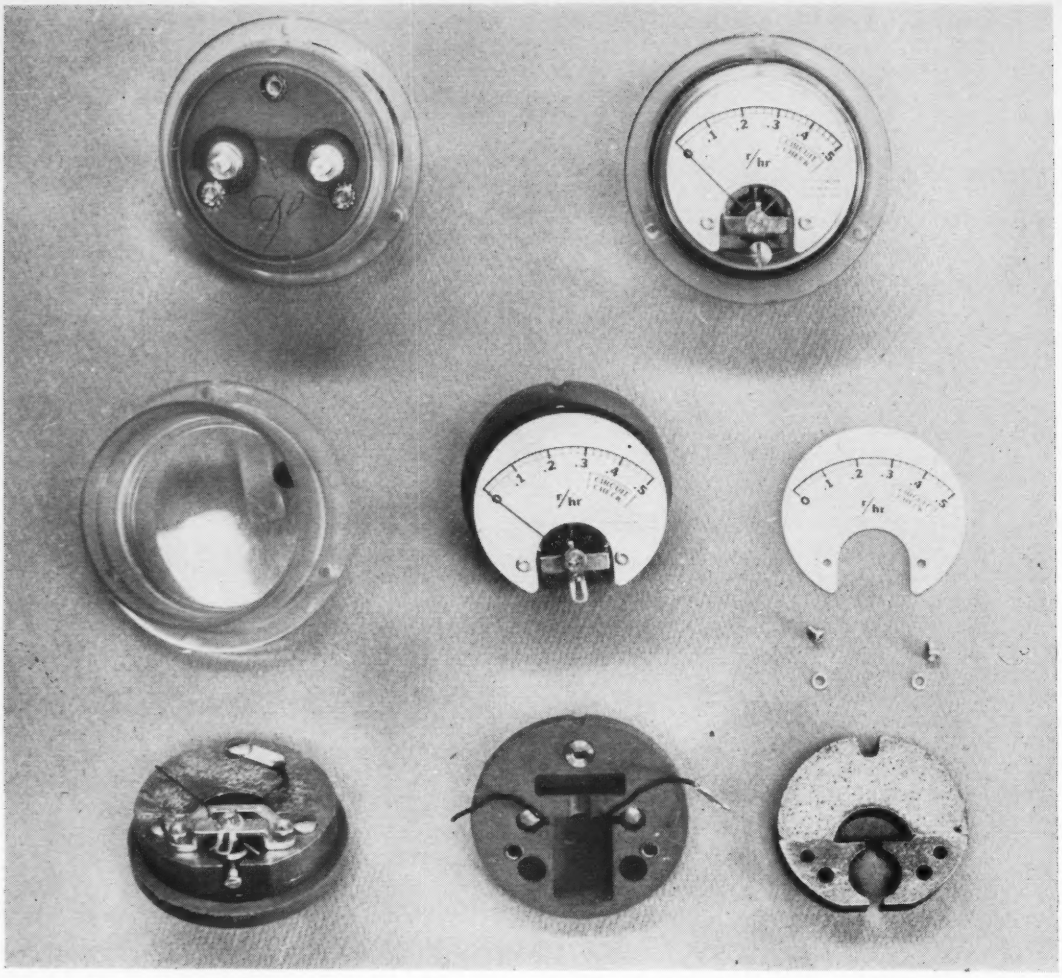
Flying test bed

This Bristol Sycamore helicopter is to act as test bed for extensive tests on rotor blade de-icing equipment at the Aeronautical Establishment in Ottawa. The tests are to be carried out in order to evaluate under actual flying conditions the performance of Goodyear blade de-icing equipment. (207)



Tops for wear resistance

High resistance, low friction and dimensional stability resulted in this fuel pump part being made from a new molybdenum disulphide nylon. (208)



Front and rear views of the completed meter are shown in the top row. Visible features are the one-piece molded plastic case of clear butyrate and the molded rubber base. The movement is mounted on the base with small screws. In the case, note the shoulder and the key slot. Third row shows the Alnico magnet with pole pieces (r) and the rubber base (centre), which are combined at the left with the coil assembly and bracket to form the complete movement. An integrally mounted stop may be seen at the bottom of the movement.

Much improved and yet it's cheaper!

Radical design changes have made possible extreme sensitivity and ruggedness at a cost saving

As the result of radical design changes, a new panel meter has been developed with an "impossible" combination of extreme sensitivity and ruggedness, at a cost almost 20% less than that of comparable previous models.

Several design features of the new meter, manufactured by Assembly Products, Inc. are thought to be new to the instrument industry.

Model 253-E is a D'Arsonval meter with a full-scale range of zero to 20 microamps. Specifications required it to pass the standard military 1,200 ft lb shock test. Actually, however, the new model has survived tests more rigorous than this, tests that have, in fact, ruined other meters that could take the standard punishment.

Previously, most ruggedized panel meters have had gasket-sealed metal cases, with rubber molded to the

"It is believed to be the first all-rubber base in an indicating meter"

cases to provide shock resistance. The movements have been attached to metal inserts "floating" in the rubber. Molding of rubber around metal is a relatively costly procedure, however.

To cut costs and still provide a meter with outstanding shock resistance, and one which was interchangeable with meters already in use in the field, the designers introduced the following new features on Model 253-E:

1. A one-piece molded plastic case of clear butyrate, including the lens and flange but not the back (see figs. 1 (a), (b) and (c)). Butyrate was chosen because its outstanding characteristic is its flexibility and give, in contrast to certain other clear plastics, used for similar purposes, which are brittle and tend to shatter under shock.

This design produced a meter completely sealed from the front, as called for in the specification. The only possible leakage point was the zero adjuster, which was rubber gasket-sealed.

Use of butyrate did raise the problem of static electricity, however. To prevent static charges from disturbing the meter reading, the butyrate is treated with a special liquid compound that renders it nonstatic.

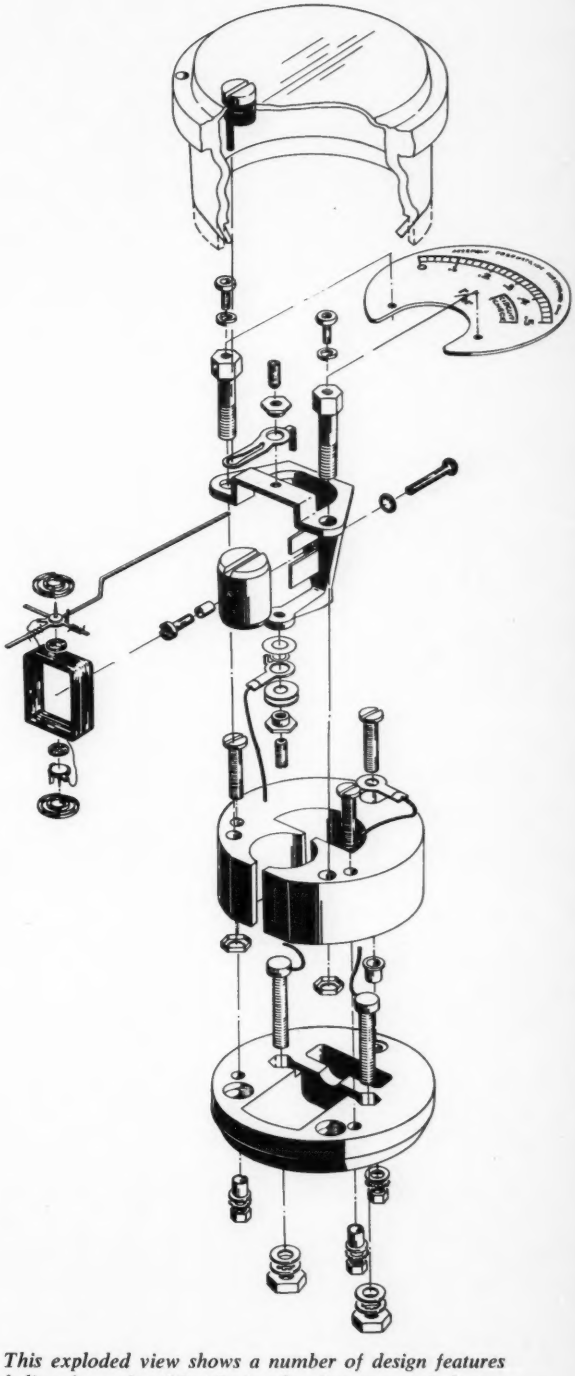
The molded rubber base

2. The entire base of the meter fig. 1 (d), upon which the movement is mounted by means of small screws, is of molded 90-durometer rubber without metal inserts. This is believed to be the first all-rubber base ever used in an indicating meter. The base has a beveled outer edge. After the case is slipped over the rest of the meter, the base end of the case is sealed to the rubber by a special machine that first crimps the case, by means of controlled heat, to the beveled edge of the rubber. Although the specifications did not call for the rear of the meter to be completely sealed against water, experience has proved that the meter has adequate sealing.

3. Glass jewels, made shock resistant by rubber backing, are used instead of the usual sapphire jewels. Glass jewels are cheaper, of course, and in this case perform just as satisfactorily.

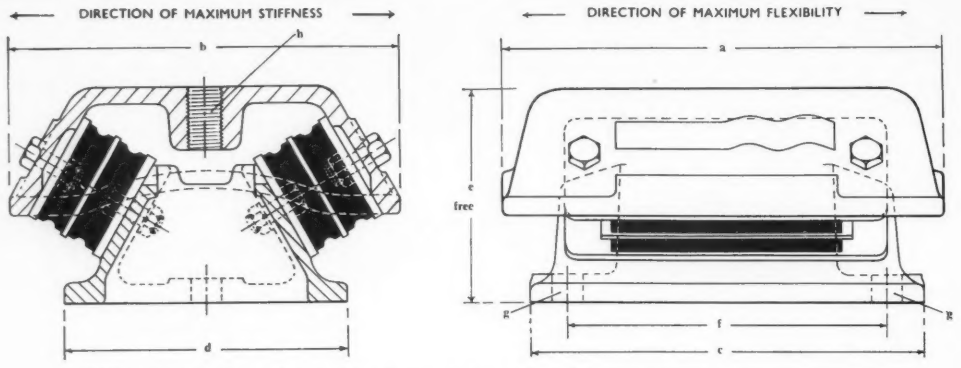
4. Special coil cementing and baking techniques were developed so that the coil can be used without the aluminum bobbin on which it is originally wound. The free-standing coil, obviously much lighter than if the bobbin had not been removed, will withstand a 4 lb crush test. No. 49 wire is used in the coil, which has a resistance of 2,850 ohms. The bobbin is Teflon coated, so that the wire and cement will not stick to it when it is removed after the coil is baked.

5. Miscellaneous design features include making the pointer and balance arms from a single piece of stamped brass, instead of the conventional two or three separate pieces that are more expensive and not as strong; redesigning the balance weights on the moving coil so that they now screw on instead of being pushed on; and deliberately setting the pivot axis off-centre on the coil so that balancing time can be cut to a minimum. This feature permits the tail piece weight to be smaller than usual, less in fact than one third conventional size. ★



This exploded view shows a number of design features believed to be "firsts" in the instrument industry.

Ideas round-up



Differences in the design and hardness of the rubber elements gives variety to mountings.

Rubber sandwiches make a flexible mounting

Flexible mounting problems are rarely alike. The machines may be identical but the nature of the foundation, the proximity of other equipment, the method of driving, working conditions and space available will vary. All these factors influence the choice of mounting.

No flexible mounting will satisfy all requirements: the unit for a generator set may be far too big for an aircraft engine. It is possible, however, to combine in one type of mounting a wide enough range of characteristics to cope effectively with many of the vibration problems in a particular class of work. In this respect the Metalastik Cushyfoot mounting has much to commend it for industrial machinery.

These mountings are produced in only two standard sizes but, by varying the hardness and design of the rubber elements, loads of 200 to 3,500 lb. per mounting can be supported with deflections which may be as high as ½ in. The ability of this mounting to meet varying conditions is further increased by the different degrees of flexibility, depending on the direction of the load.

This variation is due to the method of construction. Cushyfoot mountings are made from two castings united by oblong rubber-welded-to-metal sandwiches. The upper casting is attached to the machine base by a single bolt and its umbrella shape protects the rubber from damage and oil contamination. The lower casting is attached to the foundation by two bolts. In some cases it is possible to avoid the use of bolts or other positive attachments by means of rubber friction pads of narrow section. One of these pads is placed between the machine foot and the mounting, whilst a second pad goes between mounting and foundation.

When loaded vertically, the rubber sandwiches are in shear and compression, a combination which gives good deflection and a high load-carrying capacity. A horizontal load applied longitudinally puts the rubber in shear, in which condition it is most flexible. With a horizontal load applied at right angles to the length of the mounting, the rubber is mainly in compression and at its stiffest. Full use of this variation in stiffness can be

Range	a	b	c	d	e	f	g	h		Weight of unit
								Normal	Maximum	
A	in. 4.75	in. 5.0	in. 4.5	in. 3.25	in. 2.8	in. 3.5	dia. in. .437	dia. in. .375	dia. in. .750 Whit.	lb. 5
B	9.0	8.0	8.0	5.75	4.3	6.5	.687	.500	.875 Whit.	22

A	Mounting Ref.	A0	A1	A2	A3	A4
	Load	800 lb.	600 lb.	400 lb.	300 lb.	200 lb.
	Deflection	0.21 in.	0.23 in.	0.24 in.	0.23 in.	0.22 in.
B	Mounting Ref.	B0	B1	B2	B3	B4
	Load	3500 lb.	2400 lb.	1800 lb.	1200 lb.	600 lb.
	Deflection	0.22 in.	0.22 in.	0.22 in.	0.22 in.	0.25 in.

made: in fact the nature of the application determines the disposition of the mounting to give the best results.

When a belt drive from a separately mounted motor is employed, the mountings are arranged so that their maximum stiffness resists the belt pull: that is, the length of the mounting is at right angles to the line of the belt. With a multicylinder vertical engine and generator on a common frame, the mountings are disposed so that their greatest flexibility is available for the absorption of transverse vibration. In a fore-and-aft direction the mountings are stiff but there is practically no vibration to damp out. When three or more mountings are disposed symmetrically about a vertical axis, the stiffness of the suspension is the same in all directions. This disposition is particularly useful for centrifuges.

In the application of flexible mountings, vibrations above 1,000 cycles per min rarely give trouble. However, when the frequency falls below 1,000 cpm and shocks as well as continuous vibrations are encountered (as is often the case), the problems are more complex.

A deflection of 0.15 in. will cope satisfactorily with most vibrations above 1,000 cpm but higher deflections are required for lower frequencies and for shock loads. A deflection of 0.15 in. can be provided without much difficulty, but to obtain an 0.25 or 0.50 in. deflection in a mounting which is stable is difficult. (209)

An outboard engine designed to be quiet

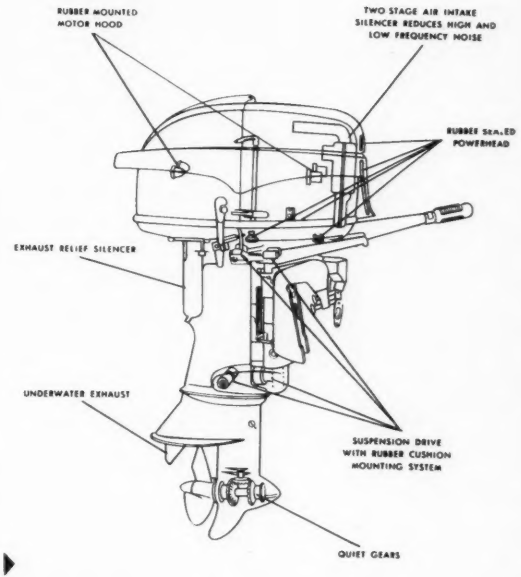
People who live or take their holidays along the shores of lakes and rivers will bless the engineers of the Outboard Marine Corporation of Canada for having produced a quiet outboard engine. There are four main sources of outboard engine noise; here is how engineers dealt with them:

Exhaust noise is largely suppressed by exhausting under water. The back-pressure is too high for engine idling, however, so a small vent is needed above water and this was fitted with a muffler. Also, this vent was used for the cooling water outlet, so that, at high speeds, the water closes it off completely.

Inlet pulsations are suppressed by a muffler, which is a chamber fitted with a fibreglass lining. Large engines have a resonance chamber as well.

Mechanical noises have been designed out as far as possible and those that remain are suppressed by enclosing the engine in a cover insulated from engine vibrations.

Boat noises are vibrations of low frequency from the engine that are broadcast by the hull of the boat. They are suppressed by insulating the engine from the boat by flexible mounts. (210)


RUBBER MOUNTED MOTOR HOOD
TWO STAGE AIR INTAKE SILENCER REDUCES HIGH AND LOW FREQUENCY NOISE
RUBBER SEALED POWERHEAD
EXHAUST RELIEF SILENCER
UNDERWATER EXHAUST
SUSPENSION DRIVE WITH RUBBER CUSHION MOUNTING SYSTEM
QUIET GEARS

Here are the silencing features in the new outboard.

Army and RCAF have a new field telephone set

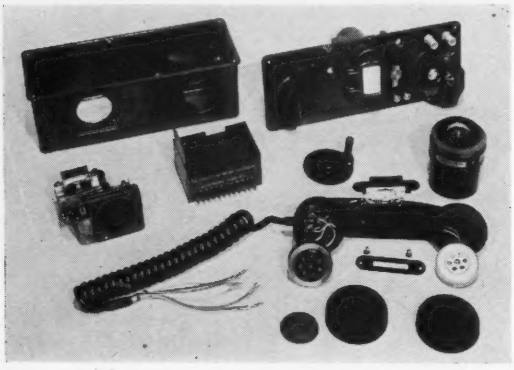
Sending a message over the new field telephone set.

The need has arisen during the last few years for a field telephone set to replace the familiar F and L types that have been in use for some fifteen years. This resulted in the development by the Bell System of the TA-43/PT set.

This new set was approved by the Canadian Army after extensive tests had shown that it would meet their field requirements and Northern Electric Company undertook to manufacture it for the Army and the RCAF.

Basically the TA-43/PT set is a lightweight, waterproof, shockproof field telephone set having a range of about 25 miles. The set will operate on either common battery, local battery or a combination of these by the mere flicking of a switch. In cases of emergency it will operate over a range of about five miles without batteries, by using the receiver as a sound powered transmitter unit.

The set consists mainly of a handset and a die cast



The major components of set before they are assembled.

aluminum case. The handset contains the receiver and transmitter units and a press-to-talk switch. The case contains the network, magneto, signaling buzzer, batteries, line switch, line terminals external battery connections and circuit selector switch. All the components of the aluminum case are mounted on the cover or panel of the case, with the exception of the magneto.

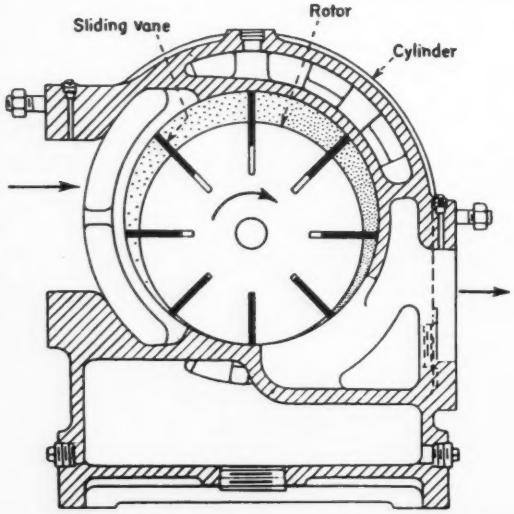
On local battery operation, the transmitter is energized by two flashlight batteries in the set by pressing the press-to-talk switch. When operating on common battery circuits the talking and signaling currents are both supplied by the telephone exchange and the press-to-talk switch is not used. Many desirable features of the 500-type telephone set have been used in the circuit design, thus providing the set with improved transmission over previous army telephone sets.

From the standpoint of mechanical design, the set has been constructed to withstand extremely severe punishment. Operational requirements include the ability to withstand storage temperatures ranging from —80 deg F to 160 deg F; atmospheric pressure changes ranging from sea level to 50,000 ft; exposure to salt spray for 100 hours; vibration, gun blasts, dropping on concrete from a height of 2½ ft and submersion in 3 ft of water for 2 hours. At the conclusion of these tests, the set must still be capable of operating with a decrease in efficiency of not more than 3% without mechanical damage except for superficial scars.

In order to meet such rigid test requirements, the use of special materials was essential. The diecastings forming the case (which consists of a housing with a panel lid or cover) are constructed from a high strength aluminum alloy. The handsets are made from a special phenolic molding compound which contains a certain amount of rubber and is capable of standing up to the drop test without damage. The rubber used in the various waterproofing gaskets is specially compounded to remain flexible at temperatures as low as —40 deg F. All fabric parts, such as the carrying case, textile parts of the cord, wire insulation and also printed information (like codes, dates and part numbers) have been made fungusproof, either by varnishing or by saturating the part in a fungicidal solution.

The ringer usually found in a telephone set has been replaced by a buzzer in the TA-43/PT. The signal given out by this buzzer is a very distinctive one, not unlike the sharp tapping sound made by a woodpecker. This means that the signal can be heard over the high background noise level of battle conditions. A volume control knob on the panel of the set permits the operator to reduce the buzzer signal to a mere whisper in order that the sound can only be heard in the immediate vicinity of the set location. This arrangement is invaluable for maintaining communications to outposts in exposed positions. (211)

Rotary vane compressors have a high output



The rotary vane compressor is simple in principle.

Because of the need for higher output from smaller machines, the two older types of air compressor (the reciprocating piston and the turbo types) are giving way to the rotary sliding vane type. As well as giving a higher output, this compressor has many of the good points of the other two types, but few of their drawbacks. It has therefore been a logical contender in many areas where the reciprocating or turbo types have been used exclusively.

The rotary sliding vane compressor provides the same positive displacement of air as the reciprocating piston type. It can therefore be used to furnish the medium pressure outputs (around 100 psi) for which the reciprocating type had to be used exclusively, because this pressure was not economical with the turbo type.

As will be clear from the cross-section of a typical rotary vane compressor (fig. 1), the sliding vanes are thrust against the housing by centrifugal force and thus form sealed-off compartments for providing a positive-displacement pumping action. If the vane is made of laminated plastic, it will be softer than the metal housing and wear will be confined mainly to the plastic vane. Wear of the metal housing will be practically elim-

Continued on page 58

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inated and the vane can be easily replaced with a new one when worn. This is much better than re-machining or replacing a worn housing.

The wear on the blades is of course, greatly reduced, because laminated plastic is much lighter than metal (it is half the weight of aluminum).

However, the laminated plastic used for the vanes has to be correctly engineered for the job. It must be easy to machine to close tolerances to fit accurately the close-fitting groove in which the vane slides. It must resist warping (or swelling), particularly when subjected to the oil used for lubricating the vanes. It must also resist warping when subjected to the high temperature gases often present in compressors, and to moisture-laden air, particularly when used for supercharging internal combustion engines.

The rotary vane compressor has already found application in the field of portable air power supplies for the construction field and in superchargers for internal combustion engines. It has also been successfully applied to air motors as well as compressors.

One example is the Ingersoll-Rand Gyro-Flo portable air compressor, developed in conjunction with Synthane Corporation, plastic manufacturers. The use of a rotary sliding-vane compressor overcomes many of the limitations of a reciprocating unit for portable service. Valves, pistons, rods and clutch are no longer used and this results in a reduction of 40% in the wearing parts to be maintained.

The compressor is an oil-cooled, rotary sliding-vane type. Cooled oil is injected directly into the air during compression. This atomized oil mixes with the air and absorbs much of the heat of compression, so that air temperatures are at least 100 deg F lower than in other types of compressor.

Figure 2 shows the compression cycle of the Gyro-Flo from which it will be seen that the rotor is eccentric with the compressor housing.

The air-intake is shown at (a), whilst (b) indicates how the air is gradually compressed as the pockets get smaller. (c) shows the greatly reduced pocket as the compressed air is pushed out through the discharge port. The continuous rotary action produces a steady flow of compressed air without pulsations and without vibration.

To ensure that the rotor blades slide freely in their respective slots was an initial design problem. Since the centrifugal force of the rotor throws the blades into continuous moving contact with the housing wall, the blade material has to be long-wearing and have a low coefficient of friction. At the same time, it must have good dimensional stability and machinability. To fulfill all these design considerations use was made of a specially processed, fine-weave cotton fabric, impregnated with thermosetting phenolic resin binder, commercially known as Synthane Grade LB. (212)

Breadboard model allows testing before production

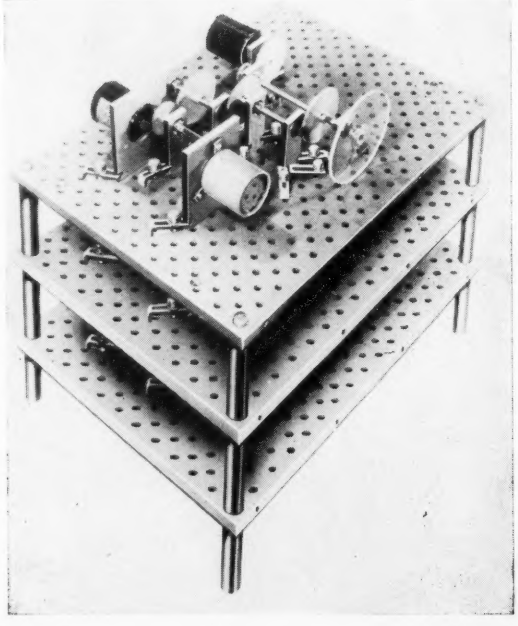
An erector set for design engineers, that does away with costly model-shop design and testing, was exhibited by Servo Corporation of America at the 11th annual Instrument-Automation Conference and Exhibit in New York.

With these kits, the design engineer can quickly and easily assemble (in erector set fashion) the appropriate components — all precision manufactured — and test, correct and finally prove the design of his instrument or system. Faulty and inadequate components are discovered and specifications corrected before (not after) production has begun. Breadboard models economically and efficiently bridge the gap between drawing board schematics and production models.

These Servoboard kits combine mounting boards, hangers, shafts, gears, couplings, adaptors, clamps and clutches, as well as differential, cam and micro-switches, load discs, pulse disc limit stops, terminal assemblies and dial or hand crank assemblies.

The mounting board has tapped holes. Components can be screwed directly to the board from the top, at any angle of assembly. No nuts are required. Mounting plates can be stacked to conserve bench space.

These precision assemblies are used for instrumentation, servo-mechanisms, motor drives, gear trains, timers and regulators. Because the effect of changing any variable is easily seen, such assembly kits are now useful for demonstrating theory and technique. (213)



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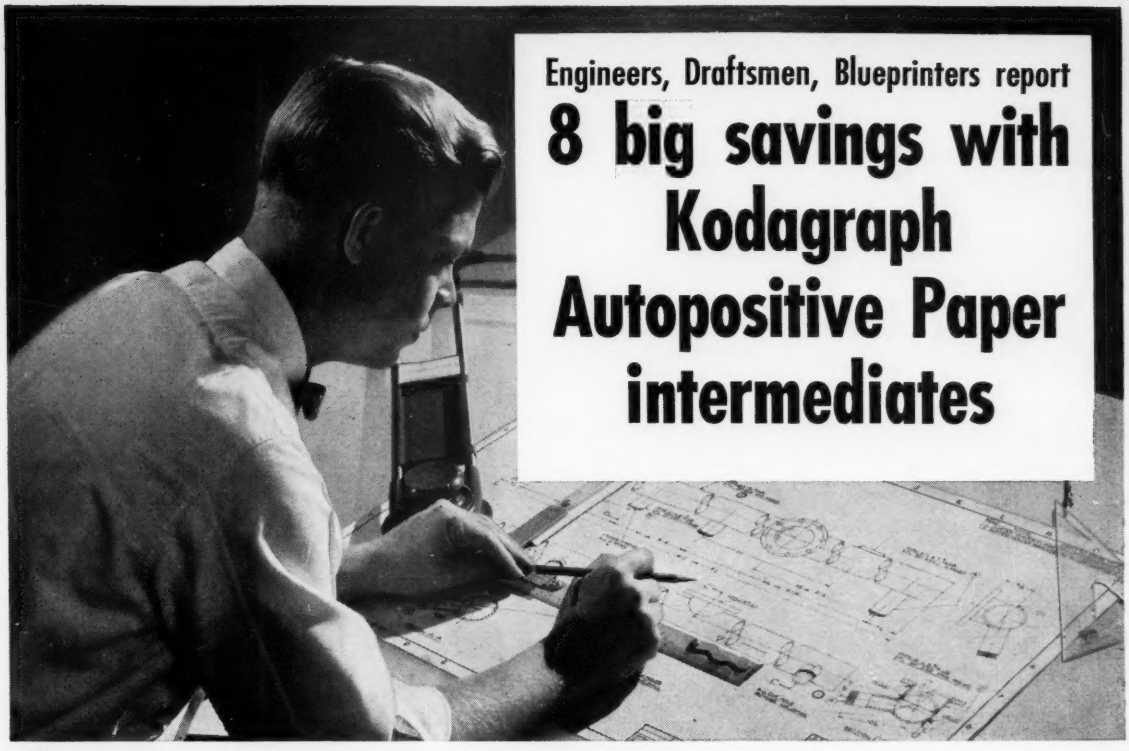

Engineers, Draftsmen, Blueprinters report

8 big savings with Kodagraph Autopositive Paper intermediates

Revolutionary Kodagraph Autopositive Paper, which produces positive photographic intermediates *without a negative step or dark room handling,* brings these savings to drafting rooms large and small.

1. Protects original drawings. Low-cost Autopositive Paper intermediates are used instead of valuable originals in printmaking, reference, mailing, and making revisions.

2. Reclaims drawings which are old, worn, or soiled. Reproducing them on Autopositive Paper cleans up backgrounds, strengthens line detail . . . eliminates redrafting.

3. Improves legibility of prints. Blueprints or direct-process prints made from Autopositive Paper intermediates are consistently easier to read than prints made from original drawings.

4. Reproduces "unprintable" originals. When extra copies are needed of blueprints, drawings on opaque stock, two-sided originals, and other "unprintables," just reproduce them on Autopositive Paper *and you have your printmaking masters.*

5. Speeds revisions of drawings. A popular short cut is to cut out or eradicate detail on an Autopositive Paper intermediate . . . and then add the new detail to this print or one made from it.

6. Eliminates redrafting standard component designs. From a file of standard component designs made on Kodagraph Autopositive Film, select the ones needed and attach to drawing form with translucent tape. Then reproduce on Autopositive Paper, add new detail and the job is done.

7. Simplifies print distribution. Instead of shipping bundles of production prints, send Autopositive Paper intermediates. Mailing costs are saved. Required number of prints can be made at other end. No overstocking this way . . . or running short of prints.

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Flange that offers two advantages

A recently introduced taper face, light-weight welding neck flange offers important technical and cost advantages where a lighter schedule of pipe must be connected to 125 lb. cast iron valves and other equipment. It is manufactured by Tube Turns, a division of National Cylinder Gas Company.

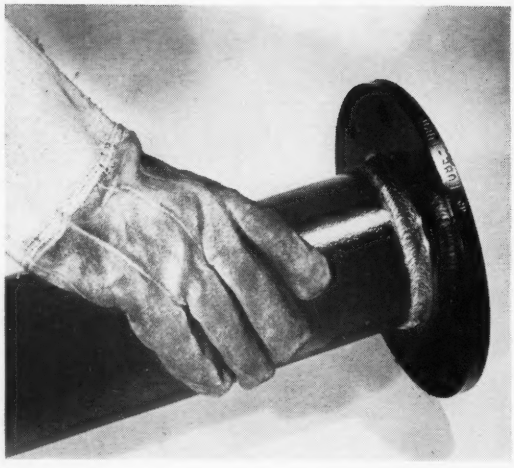
The flange, on which a patent is pending, overcomes two difficulties. First: its tapered face causes greater pressure to be exerted near the bore. This eliminates the usual problems met in obtaining a leakproof seal when a conventional flange with a full face gasket is used. Second: strain gage tests show that the new flange (equipped with a full face gasket) can be safely bolted to cast iron or semi-steel flanges. That is, it will not overstress or crack them, nor the integrally cast valves, pumps and other facilities they serve. In addition, hydrostatic tests indicate that, when the new flange is properly used, the joint is capable of withstanding approximately three times the pressure it could if the taper were omitted.

The new flange is rated at 125 lb. for water, oil and gas service. It matches 125 lb. cast iron flanges and valves made to ASA B16.1, and the bolt circle and drilling are the same as employed for ASA 150 lb. standard steel flanges.

The engineering staff of the company also points out that:

(1) When 150 lb. standard steel welding neck flanges are used with light weight, low pressure pipe they must be taper bored (or specially bored) since the Code for pressure piping calls for a maximum mismatch of 3/32 in. This involves additional machining charges. The new flange, on the other hand, is made to match light weight pipe, and no such extra expense is entailed.

(2) The new design does away with the common practice of using more costly and higher pressure class valves and flanges in order to get an adequate seal.

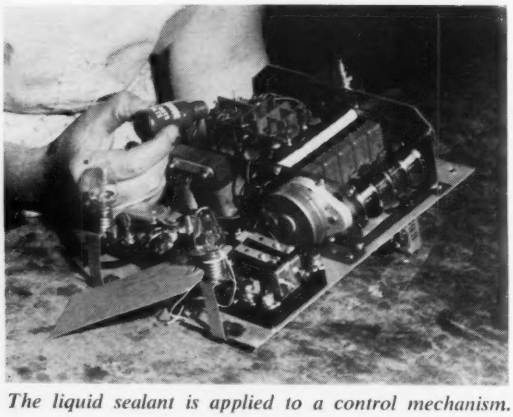


(3) The shorter hub of the flange reduces the amount of storage area needed and its lighter weight makes it easier to handle.

The Tube-Turn taper face, light-weight welding neck flange is available in 1 in. through 12 in. sizes. It is bored to match 0.188 in. and 0.250 in. wall pipe in sizes 4 in. through 12 in. within the 3/32 in. mismatch permitted by the Code for pressure piping.

The new flange is expected to be widely employed in connecting light-weight welded piping to cast iron valves, centrifugal and reciprocating pumps and compressors, gasoline and diesel engine manifolds and other equipment. It will be particularly useful to designers of gas distribution, fuel oil, water, refrigeration and similar low pressure systems. (214)

Threaded fasteners locked with a liquid



The liquid sealant is applied to a control mechanism.

A remarkable new sealant which locks threaded fasteners is now available in Canada.

This liquid sealant, called Loctite, locks standard threaded fasteners (such as nuts and bolts, machine screws and set screws) so securely that no amount of vibration can shake them loose, yet they can be removed with ordinary tools. This amazing chemical fastener introduces a valuable new approach to the problem of threaded fasteners that work loose in use.

The sealant is a clear, thin liquid which hardens automatically when confined between the surfaces of closely fitting metal parts, and forms a strong heat-and-oil-resistant plastic seal with a high shear strength. The catalytic action of the metal surfaces, aided by the absence of air (which acts as a stabilizer), causes the liquid to harden and form a tough plastic. The sealant hardens with negligible shrinkage, and threaded joints touched with a drop of the liquid therefore become completely

Continued on page 62

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Assistance in welding and fabrication techniques is one of many special services Inco makes available to its customers. In the Inco laboratories and from practical experience on the job, Inco research engineers have accumulated extensive knowledge in the fabrication of nickel and nickel alloys, and in the use of nickel alloy welding materials. These men stand ready to work with you in solving your metal problems.

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OF THE WAY

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filled with an adherent plastic. The presence of this plastic provides a locking action over the entire surface of engaged threads (not at just a few points) and ordinary fasteners so treated lock more securely than any mechanical fastener known to the trade.

The holding action resembles the combination of a multiple-tooth lock washer and a prevailing-torque type lock nut. A high initial break-loose torque due to the bond is followed by a high prevailing torque, which persists for several full turns, due to the frictional drag of the plastic.

Loctite sealant was invented by Dr. Vernon K. Krieble, retired chairman of the Chemistry Department at Trinity College, Hartford, Conn. Dr. Krieble spent many years in Canada and entered McGill University in 1907, receiving his PhD in Chemistry in 1913. He taught chemistry at McGill until 1920. While in Canada, Dr. Krieble received the Duke of Connaught medal for outstanding research.

As his official retirement from the college was approaching, Professor Krieble did not relish the idea of taking a seat on the sidelines and letting the world go by. Fortunately, his discovery of Loctite solved his retirement problem. About five years ago he came upon a series of complex compositions which exhibited unique catalytic properties. As a result of further development he perfected the new sealant and applied for patents on its composition and some of its uses. (215)

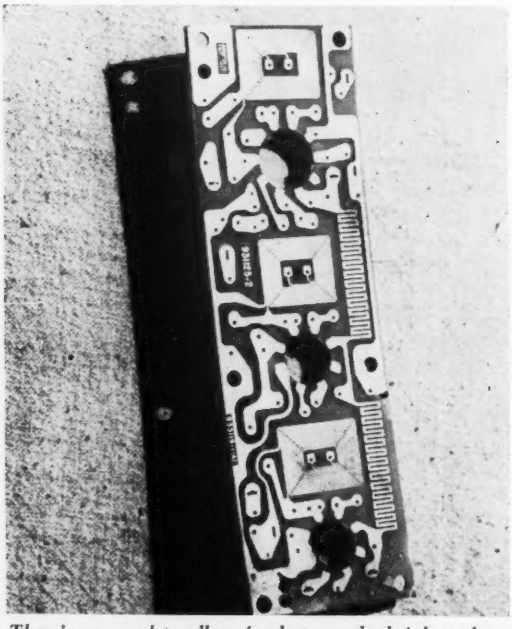
Laminate that punches clean at room temperature

Because it punches clean and sharp at room temperature, there is no need for hot punching shrinkage allowances or heating equipment when using a new paper base phenolic laminate (P-25) developed by Synthane Corporation.

The material has excellent electrical properties and with the added benefits of cold punching and cold shearing characteristics is particularly suitable for the copper clad laminates used in printed circuits.

It is a high insulation resistance and low dielectric loss at high frequencies, even under extreme humidity conditions and has been developed to meet the demand for an economical high-production fabricating material. It is available in plain sheet form or copper clad.

Engineering data is given in the table: (216)



There's no need to allow for hot punch shrinkage here.

Size:	36 in. x 36 in. sheets, 1/32 in. thick inclusive.	
Tensile Strength:	Lengthwise ..	12,400 psi
	Crosswise ...	9,500 psi
Compressive Strength:	Flatwise	25,000 psi
	Edgewise ...	.....
Flexural Strength (1/8 in. thick):	Lengthwise ..	12,000 psi
	Crosswise ...	10,500 psi
Modulus of Elasticity in Flexture:	Lengthwise ..	1,000,000 psi
	Crosswise ...	700,000 psi
Shear Strength, Izod Impact (per inch of notch):	Flatwise	.....
	Edgewise ...	0.30 ft
Specific Gravity, Coeff. of Thermal Expansion, (deg. c.). Water Absorption, (24 hr.):	1/16 in.	1.00%
	1/8 in.	0.75%
	1/2 in.	.....
Dielectric Strength (VPM):	Perpendicular to laminations	
	Short time test	.....
	1/16 in.	200
	1/8 in.	150
Dissipation Factor (1 megacycle):	.....	0.030
Dielectric Constant (1 megacycle):	.....	4.6
Maximum Constant Operating Temperature (F. deg.):	.....	250
Thickness:	Minimum ...	0.030 in.
	Maximum ..	0.375 in.
Standard Colors:	... Natural (variable tan)	
Standard Finishes:	..... Semi-gloss and dull	

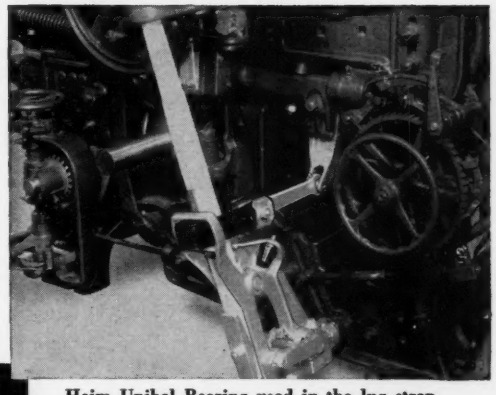
Simplification and Improvement

HEIM *Unibal* ROD ENDS

Make it possible to reduce the number of component parts formerly used in the link-type parallel and the thread cutter mechanisms on Draper looms. The result of this simplification has been an improvement in the overall operation of the loom.

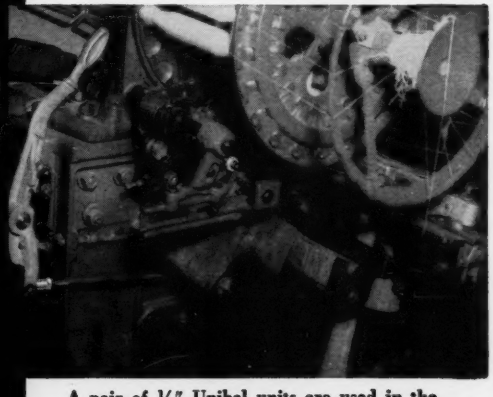
What is the Heim Unibal?

The outer member can be male (for attaching to a tubular rod), female (for attaching to solid rod stock), or a special shape to fit in with a particular design — but there is only one ball, and it rotates in bronze bearing inserts to correct misalignment in every direction. This Unibal construction provides a large surface supporting area to carry heavier loads. Here is a stock part, made in a wide range of sizes, which can take the place of a specially made assembly and perform better and smoother.



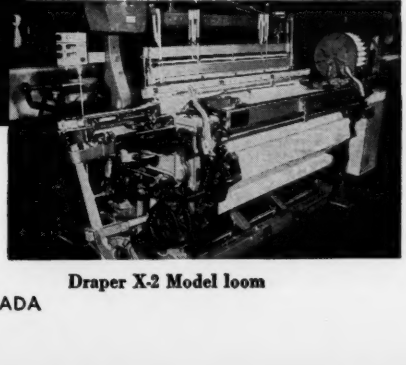
Heim Unibal Bearing used in the lug strap connector in the pick motion.

Heim Unibal Rod End



A pair of ¼" Unibal units are used in the thread cutter mechanism.

Four Heim female rod ends are used in the start-stop shipper linkage.



Draper X-2 Model loom

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Thermistors

(continued from page 36)

broad operating range. The same bridge can be made to operate over a flow range of over 100,000 to 1. If one of the thermistors of this bridge is not placed in a pipe but is mounted up in the air (where it is unshielded), it will make an excellent anemometer for measuring very low (and very high) wind velocities. Gas flow meters such as this have been made to measure flow rates as small as 0.001 cc per hr. By a special arrangement of the thermistors in such a flow meter, it can be made directional so that it will indicate the flow rate and direction in a pipe. Flow meters of this type have been used to make very sensitive rate-of-climb and rate-of-descent meters for aircraft.

Suppose two thermistors, connected in a bridge circuit, are mounted at different levels in a tank. As the liquid level rises and reaches the lower thermistor, this thermistor will be cooler than the upper one, because the liquid will have greater conductivity than air. As a result, the bridge will be unbalanced. This bridge can be made to operate a control to shut off the flow of liquid into the tank until the level drops to the point at which both thermistors are again in air. The bridge then balances and causes the valve to open and start raising the liquid level. This type of liquid level control can be made to operate to about ten thousandths of an inch. A less elaborate circuit based on this principle is shown in fig. 7. By proper circuitry, it is possible to make such controls operate in 1/100 sec after the liquid touches the thermistor or after the thermistor is removed from the liquid. Level alarms of this type are now being used in aircraft fuel cells to indicate when the cells are full and when they are empty. This is especially important when refueling in flight, for it is essential that fuel should not overflow a cell, because of the fire hazard. The big advantage of this type of level indicator over other types is that it has no mechanical or moving parts to stick or go wrong. The thermistors are permanently mounted in the fuel cell and are relatively indestructible.

These are only a few of the many interesting applications of thermistors. They can be used in some way in almost every manufacturing process and they can be used in almost any electrical or electronic equipment. The main limitation to date in their use is the limitation of knowledge of engineers who must design them into equipment in order to establish a new use. Electronics courses in the universities are not teaching new engineers how to use thermistors along with other circuit components. ★

UNI-RING offers a tremendous saving in installation time over any previous method of tapping or terminating shielded or coaxial cable. As the inner ring slides under the shielded braid, the tap wire is held between the braid and the outer ring. Single or multiple taps, from either the front or back of the connector, can be accommodated . . . A single crimp, using the same basic HYTOOLS used for installing HYRINGS, completes the uniform, secure, and insulated assembly.

The protecting nylon insulation extends beyond both ends of the UNI-RING, eliminating metal-to-metal contact and preventing harmful wire-chafing in tight locations. The UNI-RING is color-coded to indicate conductor sizes.

UNI-RING'S one-piece design insures electrical integrity, prevents heating, and eliminates noises caused by isolated metal parts.

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Quotes

Points from current papers and speeches

Gas-lubricated bearings

A paper dealing with the properties and applications of gas-lubricated bearings of the hydrodynamic (or self-acting) type, as distinct from the pressure-fed (or hydrostatic) type was given by G. W. K. Ford, D. M. Harris and D. Pantall before the **Institution of Mechanical Engineers.** Although the idea of using gas as a gearing lubricant is by no means new, it is only within recent years that requirements have arisen for the development of machines employing such bearings. The earlies known reference to the possible use of a gas as a bearing lubricant is contained in a paper by Hirn (1854), and an interesting series of experiments was performed by Kingsbury (1897), to be followed by a mathematical analysis of his results by Harrison (1913). This has recently been extended by Katto and Soda (1952).

The two machines described in some detail in the paper are in fact applications to atomic energy problems for which it would have been much more difficult to provide solutions using conventional liquid or grease lubricated bearings, but the authors consider that there are many fields of application for self-acting gas bearings to problems unconnected with atomic energy, for example, in gas-handling machinery in chemical plant, in gas turbines and compressors and in applications where cleanliness is important.

Blast resistance design

For the first time, a design procedure for blast loading is presented in Paper No. 2786, **Transactions of the American Society of Civil Engineers.** Purposely the procedure is not readily useful to determine dynamic response or deflection. The field of structural dynamics is relatively new. It is therefore understandable that nearly all the previous study that has been made on the subject of the resistance of structures to atomic blast has been concerned primarily with the analysis of the response (that is, deflection) of a particular structure subjected to a given loading. This approach is mathematically very attractive, and Nathan M. Newmark, the author of the paper, has contributed several methods of his own. However, there are two important reasons why the calculation of deflection of a given structure subjected to a given blast is not especially satisfactory from an engineering point of view:

For these reasons the writer presents without apology the relatively crude approximations in this paper as a quick and simple means of arriving at a design. These procedures may be used equally well to determine the increased strength required for an existing building. For the preliminary design or strengthening of either a structural frame or of component parts, one needs to estimate the natural period of vibration of the frame or component relative to the duration of the loading on the component and the ductility factor or the ratio of the desired limiting deflection (preferably for collapse) to the yield-point deflection. Accurate values for these ratios are not required. Using these estimates, one readily determines from the approximate relations given herein the required limit load or yield resistance of the structure for a specified external pressure or size of bomb.

Package cushioning materials

Methods of selecting and designing package cushioning materials are presented in U. S. **Forest Products Laboratory Report** No. 2031 by R. E. Jones and W. L. James. Details are given of an exact method of determining the cushion thickness required to protect a given article from damage caused by a drop of specific height, and a simplified method of determining requirements when an uncertainty of 10% can be tolerated in the level of protection provided for the article. Equations are given by which quick estimations of cushion-thickness requirements can be made.

When cushion factor-stress curves are available for most cushioning materials, the information contained in the report could be used as the basis of a cushion calculator.

Aluminum bearings

In the past, the main objections to the use of aluminum in bearings for ferrous metal machine parts has been its tendency to adhere to the ferrous metal and so cause scoring or seizing.

However General Motors Corporation has, according to Aluminium News, now completed patent applications for two aluminum alloys which should increase greatly the use of the light metal in the field of machine bearings.

It is claimed that these new alloy bearings (which are one-third the weight of tin-bronze bearings and probably cheaper to produce) will perform well under extreme conditions, having a much greater resistance to fatigue or to cracking under the pounding action to which bearings are sometimes subjected. In addition, the new alloys are highly resistant to corrosion from the acid constituents of lubricating oils that are inclined to attack other bearing materials.

Among other applications, aluminum base bearings will be particularly useful to railways, plagued for years by "hot boxes."

Mechanical cleaning

Two years ago Maytag was faced with the problem of expanding its enameling facilities to meet the ever increasing demand for appliances. At this time, metal preparation facilities were not adequate to meet desired production, so this phase of the operation had to receive consideration along with other major enameling units. The Engineering Department investigated all possible methods of metal preparation (whether old accepted methods or new developments) and found that mechanical cleaning of the shot-blast type had a great deal of appeal. The following were the reasons given by R. C. Thompson in a paper presented to the **Porcelain Enamel Institute:**

1. It answered the need for increased capactiy without expanding the existing spray pickel.
2. It put them in a good position for one-coat white application, of which some processes are dependent on a shot-blast surface.
3. Two of their spinner tubs have hundreds of extruded holes and shot-blasting eliminates the burr problem.
4. Four of their major parts lend themselves well to shot-blasting.

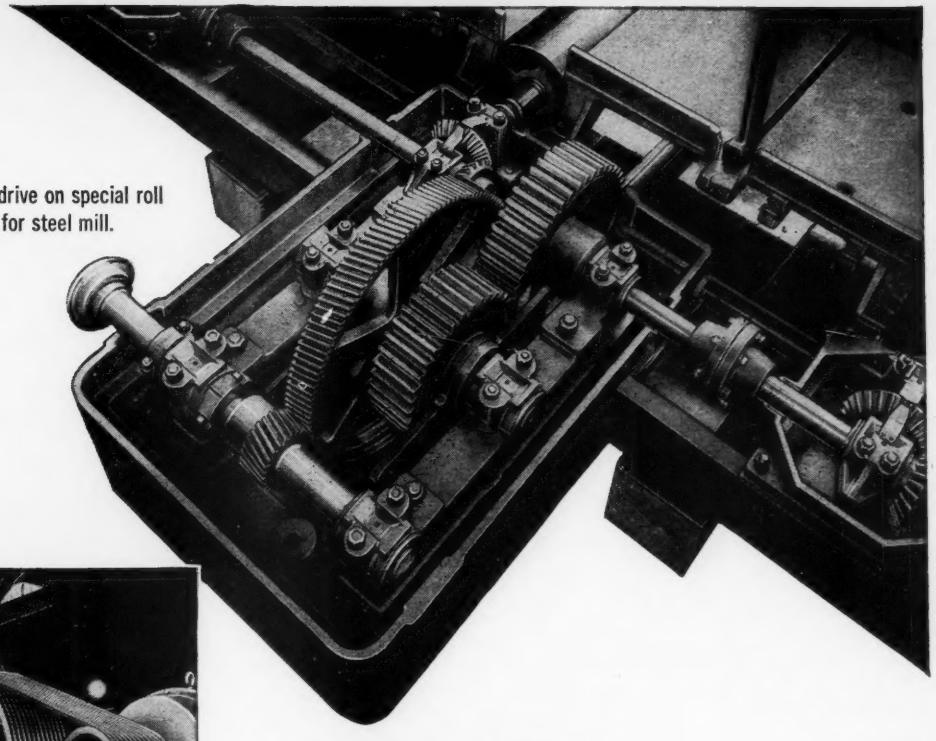
After thorough testing and experimentation, it was decided to adopt this process of metal preparation.

Scale models

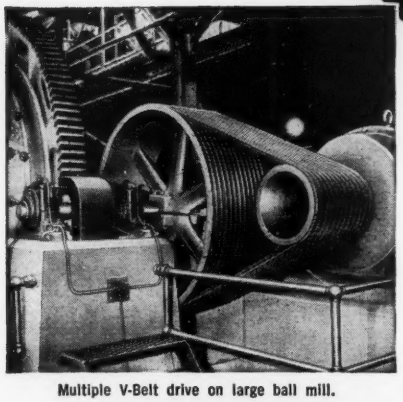
The construction of complicated plants and processes can be made easier by using scale models to help engineers visualize the design features. With these easy-to-understand miniatures of the plant, engineers and their clients can review in hours what previously would have required days.

The advantages that models offer as a design tool are described by Bruce L. Paton, design supervisor of the Fluor Corporation Ltd., in the ASME publication **Mechanical Engineering.** He states that, when models are used, all parties concerned have a more definite idea of how the plant will look before ground is broken.

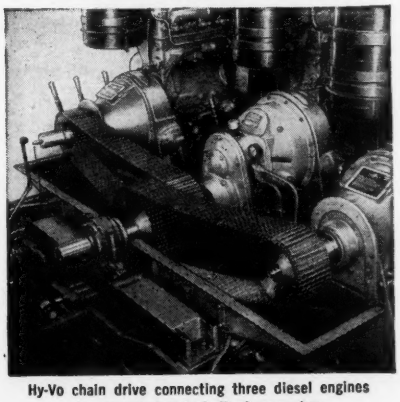
Models are also a definite aid to the construction force. Not only is it possible, with a plant-layout model, to have a more definite idea of what erection problems will arise earlier in the job, but the construction men are better able to offer suggestions to designers that will lessen costs. Field men can also more logically plan the sequence of erection.



Gear drive on special roll table for steel mill.



Multiple V-Belt drive on large ball mill.



Hy-Vo chain drive connecting three diesel engines to common input shaft of generator.

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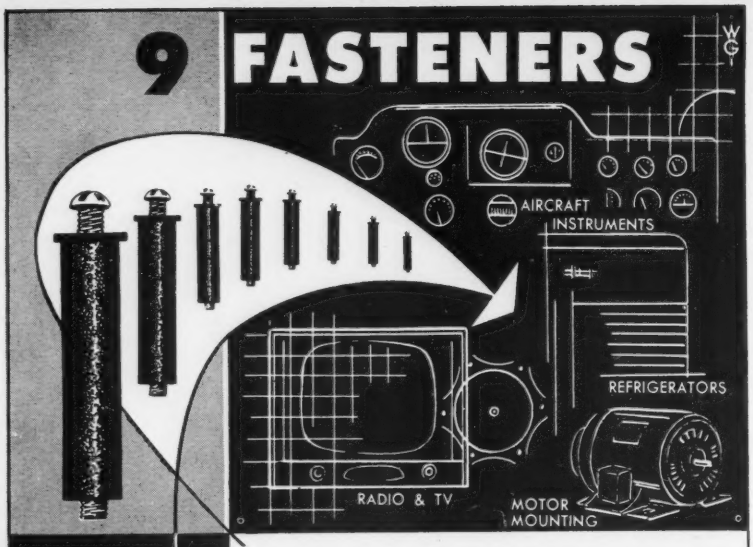

in search of new uses

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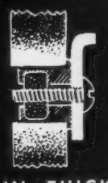
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IN THIN MATERIAL

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Letters

Readers' viewpoints . . .

Cold weather windshield:

In the November issue, page 5, there is a paragraph relating to the use of a gold film as the conducting layer in an electrically heated window. We would be very much obliged if you could supply us with the name of the Scottish firm supplying these windows.
from C. K. Rush, low temperature laboratory, National Research Council, Ottawa 2.

(We wrote to let him know that the name of the firm is Euclid (Great Britain), Motherwell, Scotland.—ED.)

Pipe Stoppers:

I would appreciate information as to the manufacturer of the pipe stoppers shown on page 45 of your article on neoprene in the October DESIGN ENGINEERING.
from M. H. Cody, technical advisor to the works manager, General Steel Wares Ltd., London, Ontario.

(We asked Du Pont Company of Canada Ltd. to supply this information direct. —ED.)

Timesaver for isometric drawings

We would appreciate receiving further information regarding the Perspector twin pantograph covered on page 29 of the December, 1956, issue of DESIGN ENGINEERING. In particular, we would like to have advertising literature, prices and the name of our closest distributor.
from A. E. Ades, Asst. Director of Engineering, Engineering Department, Trans-Canada Air Lines, Montreal Airport.

• • •

We are interested in receiving more detailed information with regard to an article which appeared in the December issue of DESIGN ENGINEERING.

The article to which we refer is "Timesaver for Isometric Drawings" which describes a machine designed for making perspective views in drafting.

We would appreciate your letting us have any descriptive literature that you may have covering this, or information as to where this Perspector is manufactured.
from W. D. Pratt, supervisor, drafting dept., Beatty Bros. Ltd., Fergus, Ontario.
(The Perspector is handled in Canada by Thermovolt Instruments Ltd. of Toronto and this information was passed on to our enquirers—ED.)

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CYPAK SYSTEMS SUPPLY THE "BRAINS"
to control a single machine or an entire factory... the most revolutionary advance in machine controls in a decade!

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CYPAK—the Product of the Year—is an outstanding example of the complete Westinghouse line of machine tool controls. A sales engineer from your nearest Westinghouse office will gladly analyze and help to solve *your* control problems. Call him . . . or write Canadian Westinghouse Company Limited, Industrial Control Department, Hamilton, Canada.

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Thermostatic control

Designed for installation in the cold air return of gas-fired wall and room heaters, a new thermostatic control is now in production by **Robertshaw-Fulton Controls.**

Known as the Unitrol 110-S, the control includes a combination pilot and main burner control valve, an automatic pilot with the 100% shut-off feature and a highly sensitive thermostat mechanism.

It is a "cold air return" thermostatic device. Installed at the base of the wall heater, it senses and reacts to the temperature at floor level as the air is returning to the bottom of the heater for recirculation.

Since the air movement across the floor and into the heater bases is the most active and rapidly moving air in the room (the company points out) the quick response to temperature changes by the thermostatic element provides comfortable control with little variation. (217)

Switch seals

A line of high pressure sealing devices, originally designed to meet military requirements, has been modified to suit the less critical needs of commercial users. Called **Hexseals,** the units are switch "boots" which fit over standard push-button, toggle and rotary switches to prevent the entry of dust, moisture, vapor or other contaminants into the switch or at the mounting hole.

Commercial versions afford original equipment manufacturers with a combination of pressure sealing and vibration resistance for only a small increase in cost. The use of Hexseals will also increase the service life of standard switches by eliminating switch failures due to the entry of foreign matter.

They are all constructed around an integral nut and when installed, replace standard panel mounting hardware on all three types of switch, thus acting as both locknut and sealing device. Since they are of one-piece construction, there are no extra parts to stock or assemble.

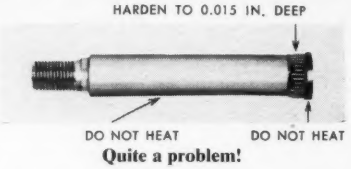
The basic sealing material offers excellent resistance to attack by petroleum or petro-chemical products, remains effective at high temperatures and has good abrasion resistance. Weathering, sunlight or salt water will not impair sealing efficiency. Hexseals are recommended for applications in the marine, air conditioning and refrigeration, food and chemical, and home appliance fields. (218)

Induction hardening

A new method of fast induction hardening has been made possible with the **Radio Frequency Company's** line of induction heaters incorporating powdered core output transformers.

A specific application of these ultra fast induction heaters is the spring-shackle bolt shown in the photo. The problem here was to harden the knurl to a depth of approximately 0.012 in. without hardening (or even heating) the head of the shank adjacent to the knurl or the shank under the knurl. The pin itself is driven into a hardened spring and the knurl must be hard to penetrate and hold. The head, however, must be soft to take the blow of pounding, otherwise it will shatter.

It was necessary to develop a completely new type of induction heater for the purpose. Ordinary induction heating techniques could provide a minimum heating time of 1 sec with a 20 kw unit. This time allowed the shank to get hot and the only solution was to use a water spray. With the new type of induction heater, the same operation takes 1/10 sec on a 10 kw machine (at about half the equipment cost). Because it is done so rapidly, no quenching is required: the residual cold of the pin does the quenching. The head remains completely soft and is not even discolored by the heat. The knurl is the only portion that is heated and hardened. The main body of the pin and the inside of the pin under the knurl remains soft and cold. (219)



Quite a problem!

Welding electrode

An all-position, low hydrogen, iron powder type electrode (called Jetweld LH-70) is announced by **Lincoln Electric Company of Canada Limited.** It is for the general purpose welding of all steels with high currents and for welding crack-sensitive steels and steels tending to produce porosity in weld metal. (220)

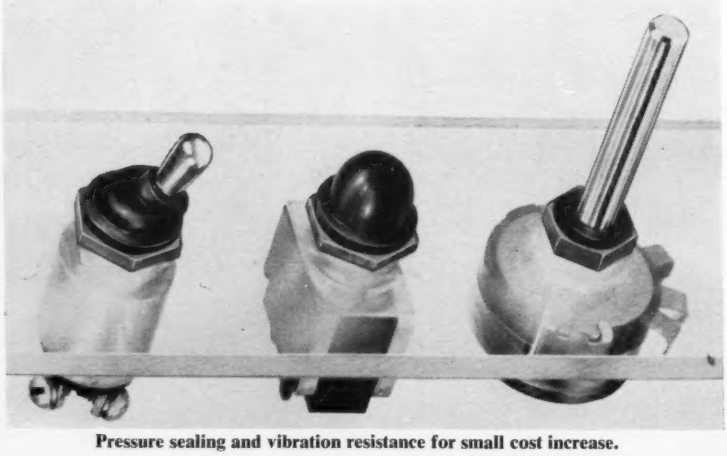
Directional valve

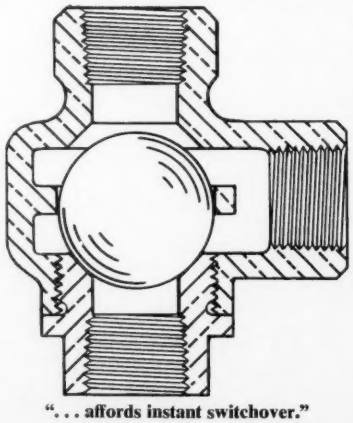
A directional valve, which affords instant switch-over from automatic to manual control of diaphragm-operated valves, cylinders and similar devices, is announced by **Valvair Corporation.**

Installed as a tee in the inlet lines, the new valve permits manual take-over from automatic control (or control from two different sources) whenever desired. It can also be used to prevent inter-mixing of supply, when two gases (or liquids) are being delivered alternately to a tank or container. Completely automatic in operation, the directional valve can be substituted for a dual top valve, the manufacturer says.

The design is simple and consists of a captive Hycar ball which shuttles between two seats in the Navy M bronze valve

(Continued on page 72)


Pressure sealing and vibration resistance for small cost increase.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CYMEL 1500 (wood flour-filled)—A general-purpose material with exceptional arc resistance and excellent dielectric strength for connector plug inserts, watt-hour meter blocks, automotive ignition parts. Brown only.

CYMEL 1502 (cellulose-filled)—A companion material to CYMEL 1500, offers similar electrical characteristics with particularly good dimensional stability for excellent insert retention. With low shrinkage during and after molding, it resists cracking around inserts. Brown only.

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body. When pressure is applied to one port, the ball shifts to (and seals) the opposite port.

Suitable for use with air, oil, water or media compatible with Hycar and bronze, the directional valve is available with ¼ and ⅜- in. NPT ports. Net open area between seat and ball is equal to the transverse area of a ⅜-in pipe. (221)

Engine preheater

Keeping equipment and vehicles on the job throughout the winter without cold weather freeze-ups and hard starting is assured by using the Zero-Start external tank type engine preheater produced by **Phillips Manufacturing Co.**

Available in two models—standard for automobiles and light trucks, heavy-duty for larger trucks and heavy equipment—the unit is quickly installed on any liquid cooled engine by connecting to the block drain.

Engineered to give quick and easy starting at below-zero temperatures, the device incorporates an improved heavy-capacity extruded element which assures rapid warm-up and extremely long life. Circulating coolant within 20 sec, the heater moves warm water freely throughout the entire block and into the cab heater for instant comfort.

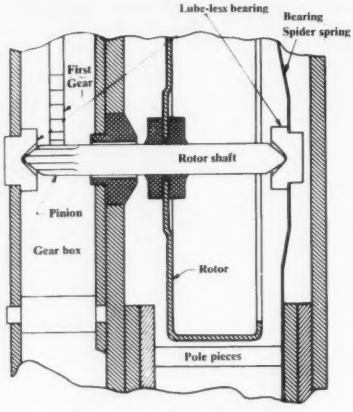
The Zero-Start engine preheater operates off any 115-volt ac/dc current supply and is rated at 850 watts (standard) and 1,300 watts (heavy-duty). (222)

Have trouble starting?

Synchronous motor

Specifically designed for incorporation in timers subjected to temperatures up to 150 deg F, a new synchronous motor has been introduced by **The Lux Clock Manufacturing Co.**

The new motor features bearings that require no lubrication. This eliminates the formation of gummy residues, the main cause of failure in timer motors which have to operate in the presence of heat.



Operates up to 150 deg F

Rounded ends of the rotor shaft ride in cup-shaped bearings, with a specially designed spider spring mount taking up end play on pivots. This exclusive development gives a constant torque output and continuous accurate positioning of the rotor pinion.

The first pinion is cut integrally with the rotor shaft, thus doing away with pinion rattle. This design also makes possible a small pitch diameter and a low speed in the gear reduction unit.

Applications of the new motor include gas and electric range timers, washer and dryer timers, animated displays, timers for conveyor systems, packaging machinery and plastic molding machinery. The motor can also be used in timers employed with diesel generators, jet aircraft ignition systems, printing machinery, circuit breakers and any other original equipment where heat poses a problem to timers. The new motor has already proved its reliability (223)

Crystal oven

An improved crystal oven, said to equal the performance of many ovens employing multistage and massive heat retaining elements, is announced by the **James Knights Company.**

The unit, the JKO-12, is relatively small, weighing only 4.6 oz., yet it is capable of meeting a specification of less than ±1 deg. C. temperature variation over a temperature range of —55 to + 75 deg. C.

Other features of the oven include a quick detachable cover, a new high-temperature heater bonding tape; a bifilar low-inductance heater winding and a radio interference filter.

The oven houses one G-9 crystal or HC-15U holder, plugs into an octal base and is available in a choice of heater voltages from 6.3 volt to 115 volt, ac or dc. Its warm-up time is 15 min at—55 deg. C. and it has a maximum power consumption of 40 watts.

The JKO-12 is supplied in heights to a maximum of 4½ in. (224)

Thermoplastic resin

There is a new thermoplastic polymer with a high melting point—Delrin acetal resin—on the horizon, according to the chemicals department of **Du Pont Company of Canada Limited.**

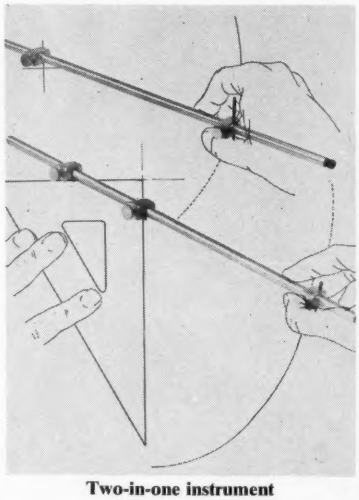
It is expected to be used in mechanical applications, for it has an unusual combination of properties including high tensile strength, toughness and fatigue life, dimensional stability, solvent resistance and resistance to deformation. (225)

Compass and ellipsograph

Development of a new two-in-one drawing and drafting instrument (a combined beam compass and ellipsograph) has been announced by the **Aero Engineering Company.**

As a logical adaptation of the traditional two-legged compass to the simpler beam compass, the new instrument is easily converted to an ellipsograph for drawing ellipses with any radius from 7/16 to 12 in., and to any degree, from 10 to 65, without the limitations of ordinary french curves or other devices.

As a simple beam compass, the principal components are two aluminum blocks which move freely along the length of the beam. One block holds a pivot pin, the other a lead point. Adjustment is provided for circles up to 24 in. diameter. Simply and efficiently designed, the new compass will not tip



Two-in-one instrument

over in use and needs only one hand.

The beam compass converts to an ellipsograph merely by changing points and adding a third block. All parts are provided with the complete set and the entire instrument is made of polished aluminum for long service. (226)

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New LOW COST GARLOCK MECHANICAL SEAL

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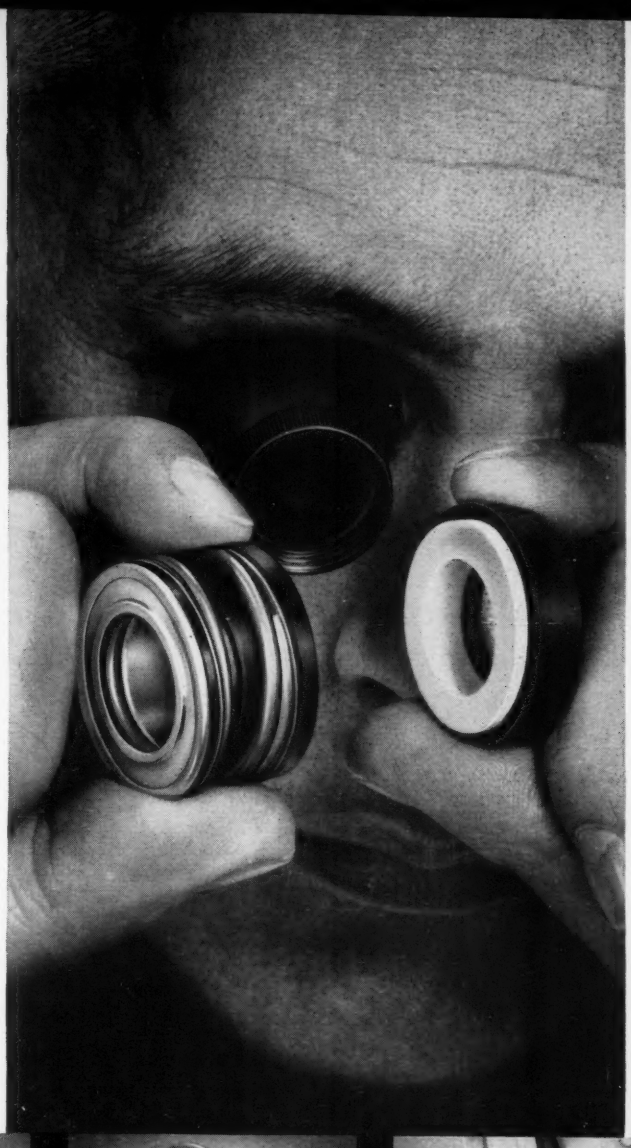
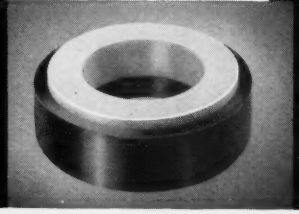
The finest quality materials, design, and workmanship have been incorporated in this new low cost Garlock Mechanical Seal for 5/8" and 3/4" diameter shafts. Other sizes available on quantity orders.

This new low cost mechanical seal is another important addition to "the Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals for every need. The only complete line . . . that's why you get unbiased recommendations from your Garlock representative.

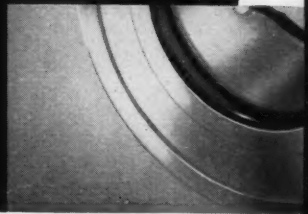


...e Carbon Seal Ring with precision ...pped surface. Regarded by all experts ...the finest material for one face of any ...chanical seal. Perfectly flat sealing sur...ce contacts stationary seat.



Stationary Seat of finest Ceramic is mounted in a molded cup-shaped vibration ring. Its sealing surface is precisely lapped for perfect contact with the carbon seal ring . . . perfectly matched for positive sealing.

Costly Two-piece Shell Construction. Shell rolls over a retainer ring which holds "O" Ring (static seal) in place and also provides a metal surface which gives you an exact mounting position. No danger of incorrect mounting due to improperly located static seal.



Static "O" Ring in Groove permits mounting seal from either direction without disturbing position in shell. Withstands higher pressures (100 psi.) and permits tighter fits than square shaped rings.

Roll Type Bellows provides greater travel than "V" type bellows.

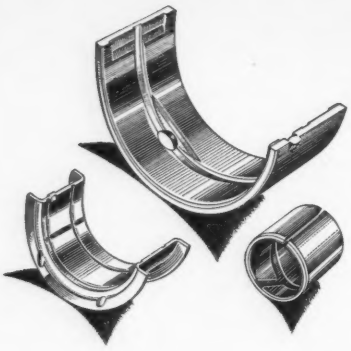
We invite you to compare this new inexpensive Garlock seal with those you are now using. It is designed for use on any rotating shaft of home water pumps, oil pumps, reduction units, washing machines, etc. Get all the facts, call your local Garlock Representative or write for data sheets on this new mechanical seal.

THE GARLOCK PACKING COMPANY OF CANADA LTD.

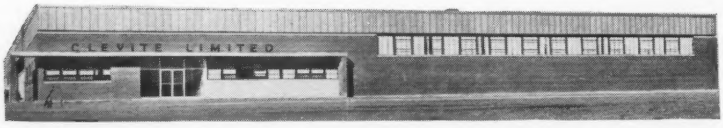
General Offices: Toronto, Ont.
Branch Offices: Hamilton, Montreal, Winnipeg, Edmonton, Vancouver

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

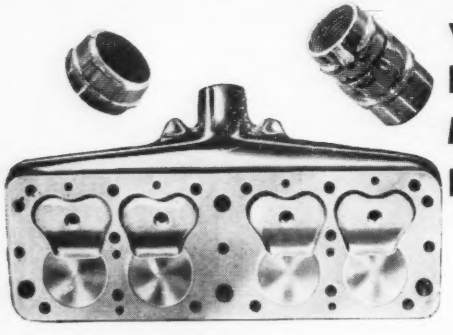


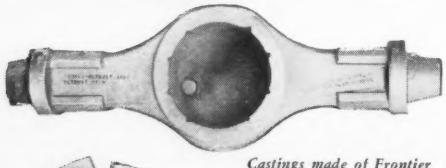
Clevite Limited, the only major Canadian manufacturer of sleeve-type bearings and bushings, regularly supplies outstanding engineering and field service to the automotive, farm equipment and appliance industries. If you use bushings in quantity, our split rolled bushings can mean improved performance and lower costs, particularly as compared with cast bronze types. Our engineers are at your service. Write or call Clevite Limited, St. Thomas, Ontario.



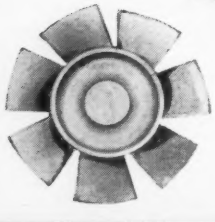
Canadian Subsidiary of Clevite Corporation, the World's Leading Producer of Sleeve Bearings and Bushings

A Modern Foundry ready to Serve You





Castings made of Frontier 40-E Aluminum Alloy are equal to the test bar in physical properties.



with a complete line of Non Ferrous Castings, including Monel, and the non-heat treated FRONTIER 40-E Aluminum Alloy

With the latest equipment and many years of experience, we solicit inquiries from Canadian Industries for copper base alloys, aluminum and bronze alloys and Titanium Aluminum Bronze Alloys. We produce FRONTIER 40-E Aluminum Alloy castings, an alloy with high strength (in sand cast conditions); corrosion resistance; resistance to shock, impact and fatigue; resistance to hydrostatic pressure. It has excellent machinability. The high tensile strength (35,000 psi, min.) and yield strength (25,000 psi, min.) are attained without heat treatment.

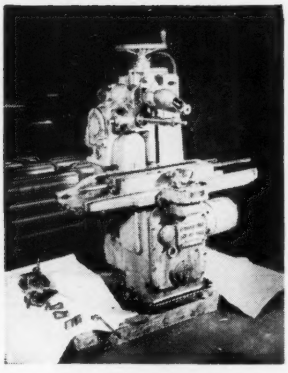
WRITE FOR YOUR FREE COPY OF THE FRONTIER ALLOY CHART TODAY!

FRONTIER BRONZE & ALUMINUM CASTINGS LTD.

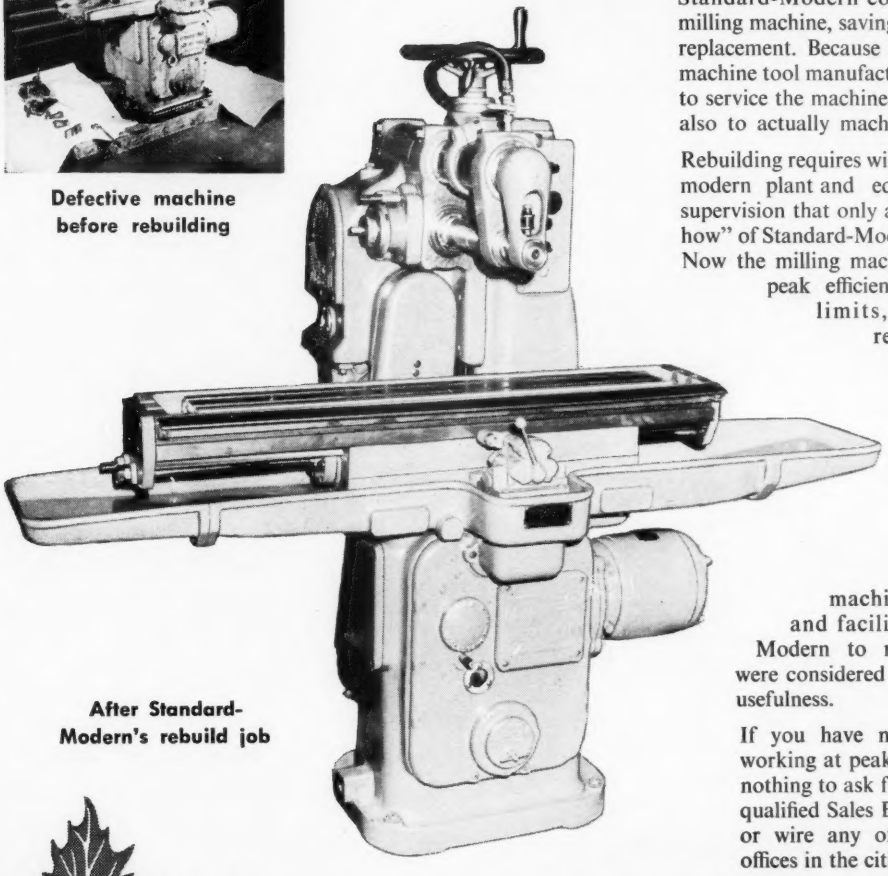
Office & Plant: Killaly Street East, at the Welland Canal, Port Colborne, Ontario, Canada

How one manufacturer avoided a capital expense of $9,000

by rebuilding this machine tool



Defective machine before rebuilding



After Standard-Modern's rebuild job

Standard-Modern completely rebuilt this milling machine, saving its owners the cost of replacement. Because Standard-Modern is a machine tool manufacturer, it is not only able to service the machines in the usual way, but also to actually machine replacement parts.

Rebuilding requires wide experience, the most modern plant and equipment, and expert supervision that only a firm with the "know-how" of Standard-Modern is able to give you. Now the milling machine again operates at peak efficiency within Schlesinger limits, saving the cost of repairs in faster, more efficient operation.

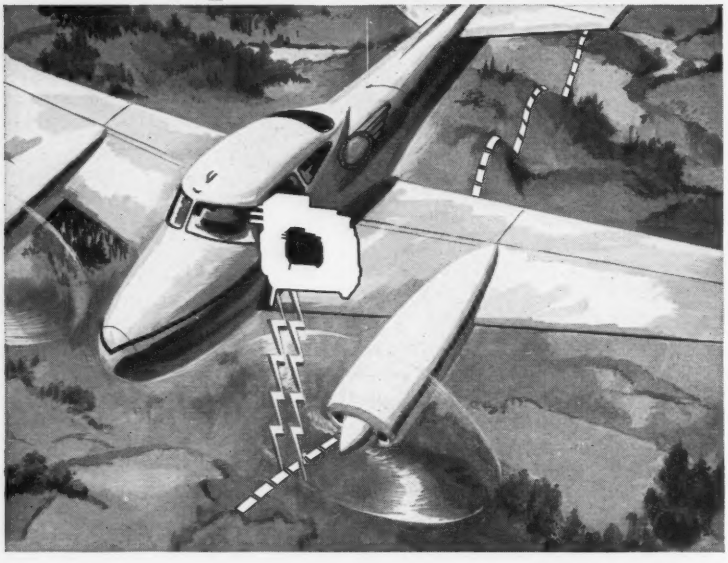
Standard-Modern's experienced Sales Engineers offer you money-saving recommendations on rebuilding or replacing defective machine tools. Experience and facilities allow Standard-Modern to rebuild machines that were considered to have out-lived their usefulness.

If you have machines that are not working at peak efficiency, it costs you nothing to ask for advice from our well qualified Sales Engineers. Write, phone or wire any of our Sales Division's offices in the cities listed below.

STANDARD-MODERN TOOL CO. LTD.
TORONTO **CANADA**

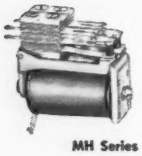
Sales Division: **The A. R. WILLIAMS MACHINERY COMPANY LIMITED**
Halifax, Montreal, Ottawa, Toronto, Windsor

Potter & Brumfield *engineering is in this picture*

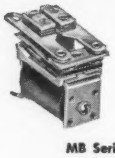


Which P&B relay did Television Associates specify

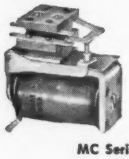
FOR THEIR AIRBORNE COMPUTER?



MH Series



MB Series



MC Series

Surveys for pipe lines, electric transmission routes and microwave paths are now made from the air, by radar. Television Associates of Indiana, Inc. developed this speedy new technique—and the equipment—which provides clients with detailed profiles of the terrain to be crossed.

Part of the equipment, an intricate airborne computer, requires relays that are fast-acting, light weight, versatile. They must have high shock and vibration resistance and remain operative in temperatures ranging from −45° C to +85° C.

Modified MH relays by P&B were specified. These miniature relays meet all Television Associates' requirements and provide high reliability in a mighty small package. Challenging relay problems are solved daily at P&B. Twenty-five years of creative engineering are behind every P&B relay. Write today for our new catalog.

ENGINEERING DATA

SERIES: MH Miniature Telephone.

CONTACTS: Up to 18 springs, maximum 9 in each stack, forms A, B, C, D, E, X and Y. AC relays are limited to a maximum of 2 poles. Various contact material available.

VOLTAGE RANGE: DC - .05 to 110 V.— AC - 6 to 230 V. 60 cycle.

COIL RESISTANCE: 22,000 ohms maximum.

TEMPERATURE RANGE: High temperature range (DC) −55° C. to +135° C. Standard DC −55° C. to +85° C. Standard AC −45° C. to +40° C. Other temperature ranges available to specification.

TERMINALS: Standard pierced solder lug holes will take (2) No. 18 hook-up wires. Adaptable for printed circuits.

ENCLOSURES: Dust cover plus wide range of hermetically sealed covers and types of terminations.

DIMENSIONS: 1-9/16" L. x 25/32" W. x 1-3/8" H. (4c Relay).

P&B Representatives in Canada: Aeromotive Engineering Products, Montreal
A.T.R. Armstrong, Ltd., Toronto • Charles L. Thompson, Ltd., North Vancouver

Potter & Brumfield, inc.

PRINCETON, INDIANA *Subsidiary of* AMERICAN MACHINE & FOUNDRY COMPANY

Manufacturing Divisions also in Franklin, Ky. and Laconia, N. H.

Fasteners

(Continued from page 41)

work. Plastic plugs (Fig. 15) are used for filling unsightly left-over production holes, to cover ventilation holes with attractive designs, as appliance feet, as temporary or replaceable plugs for evacuation holes and as drawer glides in metal furniture.

Plastic rivets (Fig. 16) are one-piece, self-expanding and easily installed from one side of the work with a positive locking action. The principle by which they work is similar to that of the plastic support illustrated in Fig. 14b.

Grommets of plastic (Fig. 17) are blind screw receptacles with many uses such as insulation spacers in refrigeration, leveling screw holders and so forth.

It would be ridiculous to suppose that the vast and constantly growing field of fasteners could be anything more than sketchily covered in an article of this length. The author has outlined the basic types and illustrated some of the more interesting developments which are taking place, particularly in the booming field of plastic fasteners.

The age of specialization is nowhere more apparent than in the fastener industry. For the most part unseen, they are playing a significant part in the quality and staying power of the products reaching the consumer. ★

No time like the present

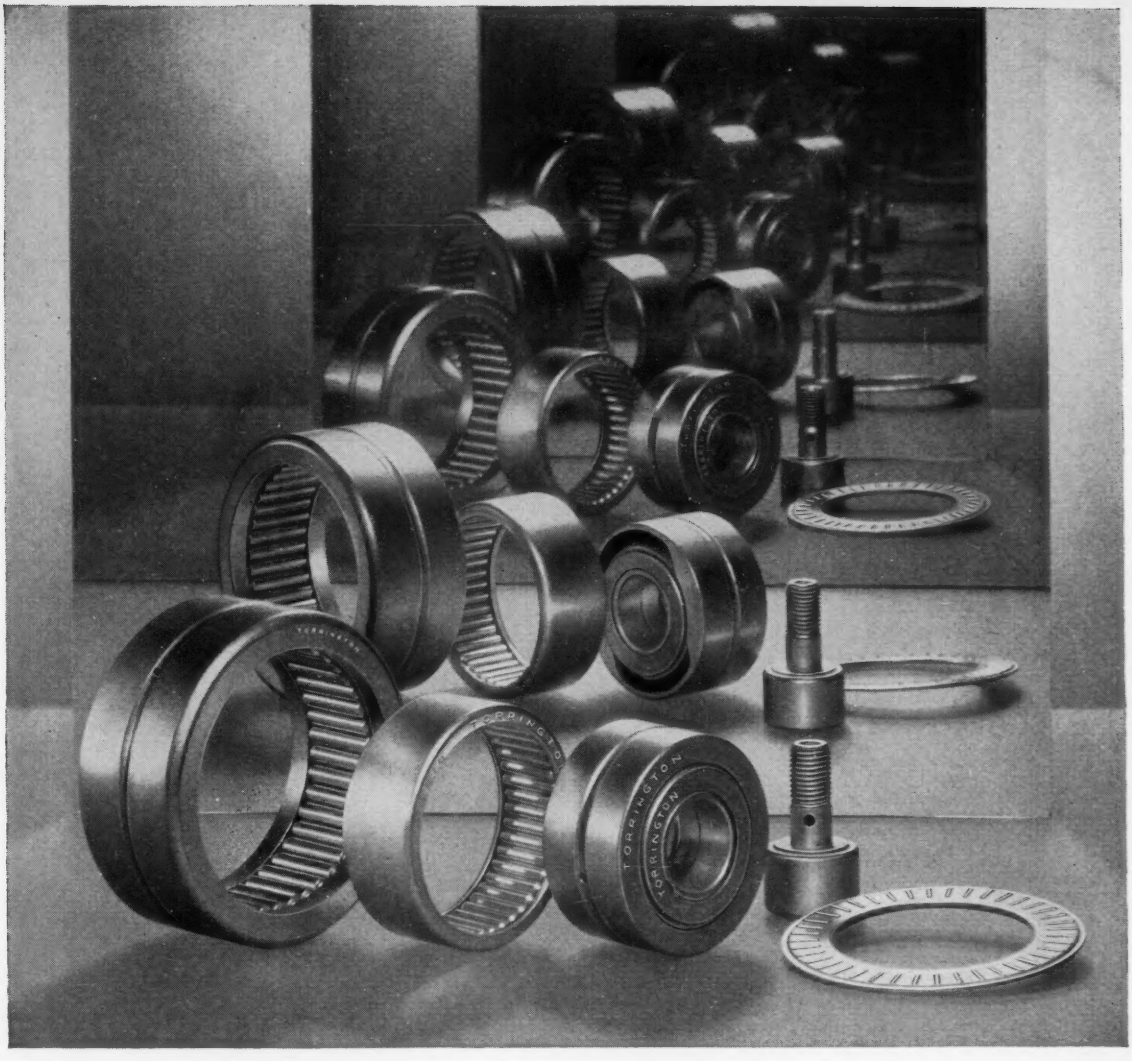
LOTS OF YOU ENGINEERS have the nucleus of an article tucked away in a drawer somewhere, either in the form of rough notes or as a rough typescript.

The reason, of course, that you haven't done anything about it is because you probably feel that nobody will be interested in publishing it—so why do all the work necessary to get it in shape for nothing?

There is somebody interested in your technical article: DESIGN ENGINEERING is always on the lookout for suitable contributions. Not that we are short of material, mind you. But it does seem a pity that good stuff should not see the light of day.

Why not act at once and tidy up that article, get it typed and submit it to DESIGN ENGINEERING? If we like it enough to publish it, you will be paid. Not a fortune, perhaps, but enough to make it worth your while.

And think of the personal satisfaction of seeing yourself in print.



For new perspectives in **NEEDLE BEARING** *design and performance*

. . . look to Torrington, pioneer in the development of every type of precision Needle Bearings.

Using carefully selected quality steels, and the most modern manufacturing methods, Torrington has developed a complete range of types and sizes of Needle Bearings for every use. There are special designs for rotation, for oscillation, even thrust applications! There are aircraft types, cam followers, and heavy duty types. Yet their unit cost is low, bringing anti-friction performance with economy.

Precision manufacture and the full complement of rollers that provides maximum radial capacity in minimum cross section make Torrington Needle Bearings top performers in the most rugged applications.

Little wonder their use has spread to countless applications in every field with outstanding success. Have you considered them for your product? Send for further information today.

THE TORRINGTON COMPANY, LTD.

925 Millwood Road • Toronto 17, Ont.

TORRINGTON BEARINGS

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

HOW TO MAKE 1000 CALLS A WEEK

. . . IN CANADA

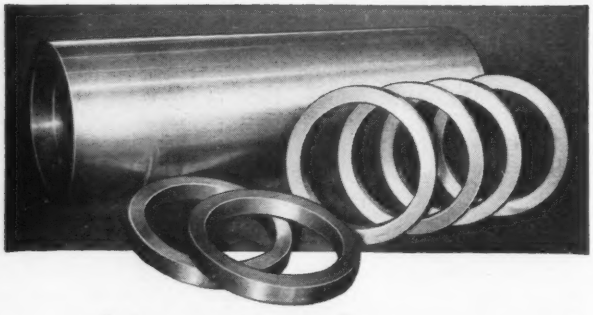
From St. John's, Newfoundland, to Victoria, B.C., is a distance of 3,980 miles. Scattered throughout this tremendous area are your customers and prospects. With even the largest sales force you must inevitably ignore some accounts at times . . . unless you also use selective business paper advertising to keep your customers informed.

No matter what your product or service, there are one or more Canadian business papers to carry your messages to exactly the field you want to reach. Supplement your personal calls by regular contacts through business papers, and keep *all* your customers informed, *all* the time.

This paper is a *business paper*—one of 100 trade . . . technical . . . service . . . and management publications covering every section of Canadian business and industry.

WHEN YOU WANT TO TALK BUSINESS USE A BUSINESS PAPER

BUSINESS NEWSPAPERS ASSOCIATION
OF CANADA
137 WELLINGTON ST. W., TORONTO, CANADA



Centricast

. . . alloy steel, bronze
and alloy iron tubular castings

Notable Improvement in Machine Design

How to improve the strength or wearing quality of certain machine parts without materially increasing costs has been a problem for many design engineers. Centrifugal casting by Kennedy is helping to solve the problem. Kennedy centricast metals are extremely dense, with excellent physical properties.

Cylinders of various diameters, lengths and wall thicknesses . . . supplied rough machined on inside and outside diameters, as semi-finished blanks, or as assembly parts fully machined to specifications, such as cylinder liners, ring gears, cages for roller or ball bearings, straight or flanged bushings and other parts.

KENNEDY'S OWEN SOUND

THE WILLIAM KENNEDY & SONS LIMITED

A DIVISION OF MILLSPAUGH LIMITED, SHEFFIELD, ENGLAND

OWEN SOUND, ONTARIO

Montreal: 1224 St. Catherine St. W.

Haileybury: John H. Brumell

Analog computers

(Continued from page 43)

He has a set of dummy controls in front of him, which he operates exactly as if he were flying the aircraft. All these dummy controls are connected to servos and potentiometers. The effect of a control movement is fed back to the pilot through instrument readings and perhaps through the "feel" of the controls. The results of elaborate tests can be read on instruments as voltages and a complete picture of the behavior of the aircraft thus obtained.

There is one more important advantage to this method of studying proposed designs. Changes (such as in the area of a control surface) can be introduced by simple adjustment of a potentiometer. Thus, a whole range of parameters can be investigated simply and easily.

Applications of analog computers are many and varied. In the oil industry they can be used for refinery control and the study of product distribution. In the automotive industry they are being used in traffic control and in the mechanical design of such parts as shock absorbers and suspension systems. They are used for process control and paper machine studies in the paper industry. The aircraft industry pioneered in the use of analog computers and they are used extensively for performance studies.

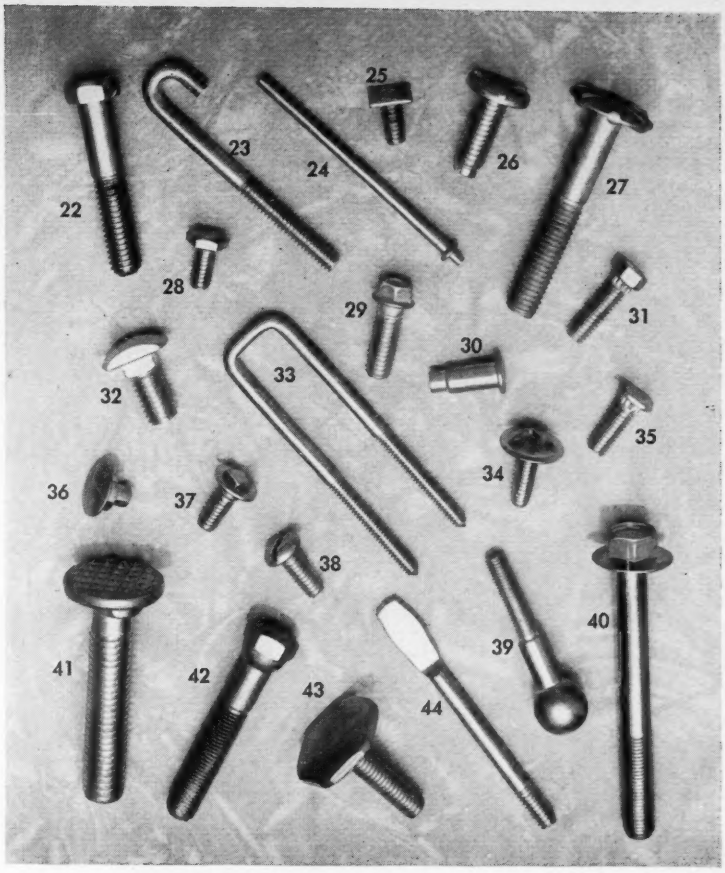
Because of the requirements for extreme accuracy, analog computers are expensive. Only the largest industrial operations have a need for the full-time use of a computer and can therefore justify the expense of owning one. The common alternative has been for an engineering team needing analog facilities to rent time at so much an hour from an organization owning one. Small desk-size computers are available, but they have a limited use because there are insufficient components to handle complicated problems. Their main value lies in enabling an engineer to "get the feel" of his problem by setting it up in a simplified form and observing the effect of varying the major parameters. This is often valuable information to have before placing a complex problem on a large machine. ★

KWIZ KORNER

Do you know what these are?

1(a). Redundant frame.
1(b). Portal frame.
2(a). Mach number.
2(b). Octane number.
3(a). Spot face.
3(b). Spot weld.

Answers given on page 85.



Special Ⓑ Fasteners—Sample brochure sent upon request

LOOKING FOR SOMETHING LIKE... *these?*

Just a few of the hundreds of Ⓑ specials used to increase strength, improve design, eliminate vibration... make better products faster.

If any of these specials could speed your production... reduce costs... do a better job than the fasteners you're now using, it will pay you to call Ⓑ.

For unusual jobs... extreme conditions, our engineers will gladly cooperate in producing the special fastener design you need.

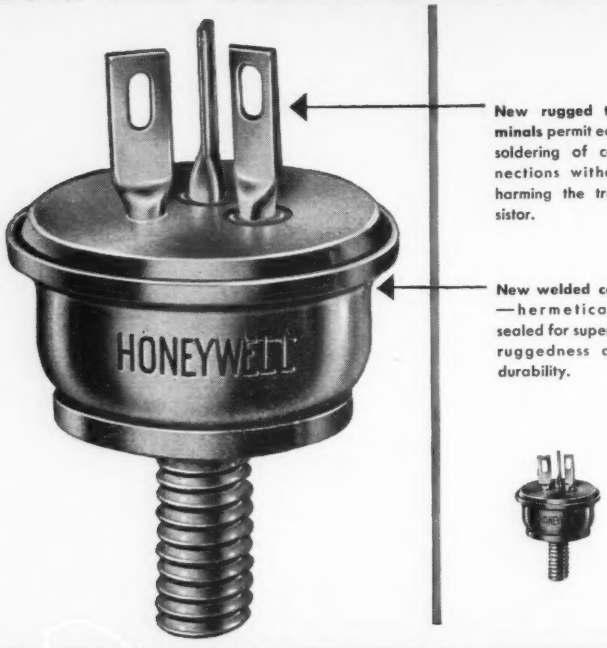
BUFFALO BOLT COMPANY
Division of Buffalo-Eclipse Corporation
NORTH TONAWANDA, N. Y.

• *3 convenient service centers*

WESTERN OFFICE	EASTERN OFFICE	CENTRAL OFFICE
Chicago	New York City	North Tonawanda
HArrison 7-2179	REctor 2-1888	JAckson 2400 (Buffalo)

Many **GOOD** *products can be made* **BETTER** *...with* Ⓑ **SPECIAL FASTENERS**

New Honeywell High Gain Weld-Seal TRANSISTORS



New rugged terminals permit easy soldering of connections without harming the transistor.

New welded case—hermetically sealed for superior ruggedness and durability.

TYPES H5, H6, H7, AVAILABLE NOW!

They're welded—so you can build new ruggedness and durability into your equipment! And the new line of Honeywell transistors gives you superior electrical performance and high, uniform power gain over a wide range of collector current values. You get long life, outstanding stability and performance. Take advantage of these new and improved transistors *now*. Mail coupon for full information today!

A COMPLETE LINE OF POWER TRANSISTORS TO MEET YOUR SPECIFIC NEEDS.

	H5	H6	H7
Input Resistance	24-48 ohms	27-54 ohms	30-60 ohms
Power Conductance	17.5-35 mhos	35-71 mhos	71-141 mhos
Current Gain, Median	30	40	60

(for collector current of 2 amps.)

Honeywell

Power Transistors

HONEYWELL CONTROLS LIMITED,
DEPT. 500, TORONTO 17, ONTARIO.
Please send data sheet TR-14 on Honeywell Weld-Seal Power Transistor.

NAME.....

FIRM NAME.....

ADDRESS.....

CITY..... **PROVINCE**.....

Anodizing aluminum

(Continued from page 49)

with various solutions (according to the color required), after which the dyed surface is sealed in the usual manner.

Organic dyestuffs when used to dye anodic films produce colored coatings of a very attractive metallic lustre. The best films are those that are thick, transparent and colorless, since they give bright, sparkling clear colors. A wide range of dyes is available for producing manufactured articles which are to be exposed only indoors, and in recent years a small number of dyes has been developed which, under rigid processing conditions, are suitable for producing color on certain architectural products for exposure outdoors. The present dyes produce colors that are color-fast for only a limited time.

The chromic acid bath

The classical chromic acid anodizing process (Bengough and Stuart) uses an electrolyte consisting of 4.8 oz/gal chromic acid at (104 ± 4) deg F for about 60 min during which time the voltage is raised in stages to a maximum of 50 volts. During the first 15 min the voltage is raised to 40 volts in 2-3 volt steps. It is maintained at 40 volts for 35 min and in the next 5 min is raised to 50 volts, where it is kept for a further 5 min. The procedure permits only batch operation. Technical flake chromic acid is suitable for chromic acid anodizing. The electrolyte is contained in a steel tank fitted with steel coils for heating and cooling purposes and automatic control of the heating and cooling circuits is desirable, but not essential. Gentle agitation with compressed air is recommended.

At the end of the anodizing cycle, the parts are rinsed in cold water; if they are to be painted, a hot water rinse may follow the cold rinse. The films may be sealed in hot water or potassium dichromate solution at 200 to 212 deg F for 15 min, although this step is often omitted.

The sulphuric acid bath

The sulphuric acid anodizing method (the Alumilite process) is most commonly used in North America. Sulphuric acid concentrations vary from 10% to 20% by weight (15 to 42 oz/gal). The process is usually operated at room temperature. The electrolyte is generally contained in a lead-lined steel or wooden tank. Suitable arrangements must be available to dissipate the heat generated in the bath. Gentle agitation by compressed air pro-

(Continued on page 85)

How to Control Corrosion on Bare Aluminum

Corrosion is a real threat to aluminum, especially to the higher strength alloys. It can be controlled by using a chemical surface treatment, with results as dramatically effective as those shown in the illustrations at the right.

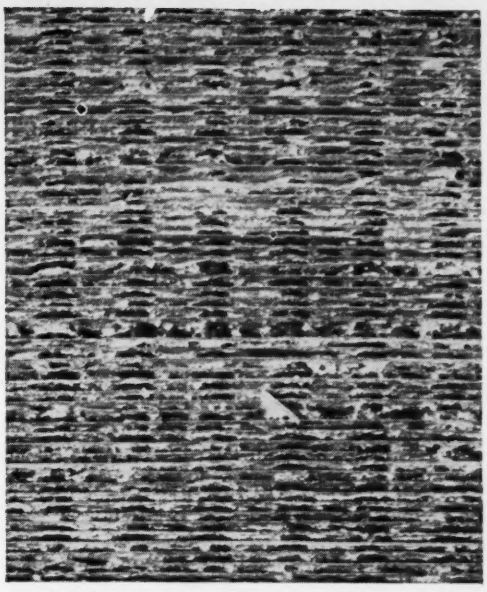
The corrosion protection is effected by Bonderite 710 or 720, applied by spray, immersion, or brush-on methods. A thin, iridescent coating, light to golden brown depending on the alloy treated, covers all surfaces of the aluminum and protects it against corrosion.

The coating produced by Bonderite is integral with the metal itself. It is flexible and can withstand moderate draws without difficulty. Arc and spot welding fabrication methods need not be changed, because the coating conducts electricity. It has good resistance to bimetallic and galvanic corrosion. Sheets, castings, forgings, extruded and rolled structural forms may be treated.

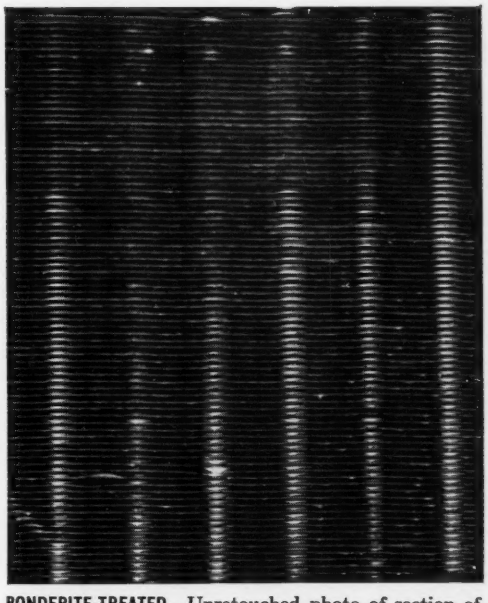
Bonderite 710 and 720 solutions are sludgeless, easily controlled, uniform in results.

These treatments may be used to increase the durability of paint finishes with equally outstanding effectiveness.

The Parker man in your territory has valuable experience to share with you in treating aluminum and its alloys. A letter or phone call will bring him to you.



UNTREATED—Unretouched photo of section of aluminum heat exchanger after 1150 hours in salt spray. Note corrosion.



BONDERITE-TREATED—Unretouched photo of section of identical aluminum heat exchanger after 1150 hours in salt spray. Note absence of corrosion.

SINCE 1914—LEADER IN THE FIELD

PROTECTED BY Bonderite PARKER RUST PROOF CO. QUALITY CORROSION RESISTANT

PARKER RUST PROOF COMPANY OF CANADA LTD.
Rexdale Blvd., Rexdale (Toronto) Ontario

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

Serving people every day...
Stan Steel Tubing
At the playground...or right in your own rumpus room. In hundreds of places... and hundreds of ways. Wherever the emphasis is on modern living...that's where people are served by products made from Stan Steel tubing.
STANDARD TUBE AND T.I. LIMITED
WOODSTOCK • TORONTO • OTTAWA • MONTREAL
STAN STEEL
WELDED TUBING
Seamless Tubing • Fabrications • Aluminum

They made a cheap forming die from epoxy

Faced with the problem of producing some steel generator blades, these engineers specified an epoxy die. It was cheap and efficient

A problem that faced CGE engineers was to design a cheap die for producing generator blades from 0.180 in. BQ8A3X steel. The design chosen was a cast reinforced epoxy resin die with a silicon carbide surface coating. These materials were used for the die:

Resin	Shell Epon 828
Fillers	325 mesh silica flour and silicon carbide
Plasticizer	Thiokol L.P. 3
Hardener	Metaphenylene Diamine (Shell C.L.)
Glass	171 or 173 Cloth with 114 Finish and 3 in. glass fibres
Pattern Material	BII Hydrocal

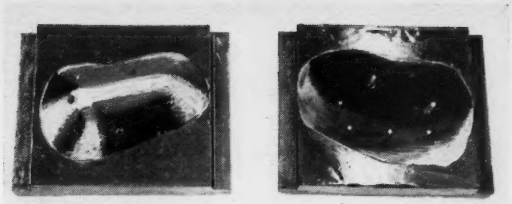
In order to cast an epoxy die for this forming operation, it was first necessary to prepare a pattern. These patterns were thoroughly dried (2 weeks at 75 deg F) and given a coating of D.C. 44 silicone grease as a release agent.

The following resin mix and hydrocal patterns were heated to approximately 80 deg C for casting.

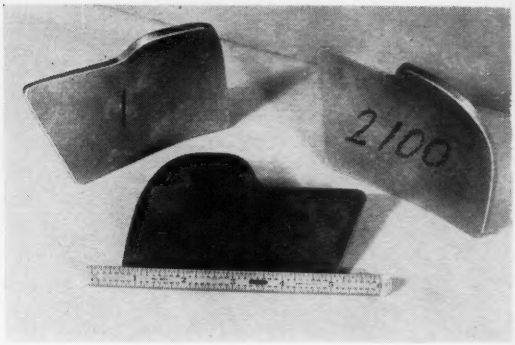
828 resin	5.25 lb. (100 parts)
325 mesh silicon flour	5.25 lb. (100 parts)
C.L. hardener	0.63 lb. (12 parts)
Thiokol	0.53 lb. (10 parts)

One piece of glass cloth cut to size was placed over the pattern and thoroughly wet with the resin. A surplus amount of resin was poured in and the glass fibres spread around and puddled into the resin mix. The alternate addition of glass fibres and resin was continued until the desired thickness was obtained, then another piece of glass cloth was put in place and sufficient resin added to give an ultimate thickness of about ¾ in. Approximately 4 oz of 3-in. glass fibre were used in each half of the die.

The cast die was allowed to B stage overnight and then baked for 2½ hr at 80 deg C and the patterns re-



This is the cast reinforced epoxy resin die specified



The 1st and 2100th blades were practically identical

moved. The casting was given a further bake of 4 hr at 125 deg C.

The die was then drilled and guide pins located, sanded lightly to remove the release agent and coated with the following mixture:

828 resin	100 parts
325 mesh silicon carbide	100 parts
C.L. hardener	12 parts

This was B staged overnight and baked for 2½ hr at 80 deg C plus 4 hr at 125 deg C.

The drilled die (coated and with the guide pins in position) is shown in Fig. 1.

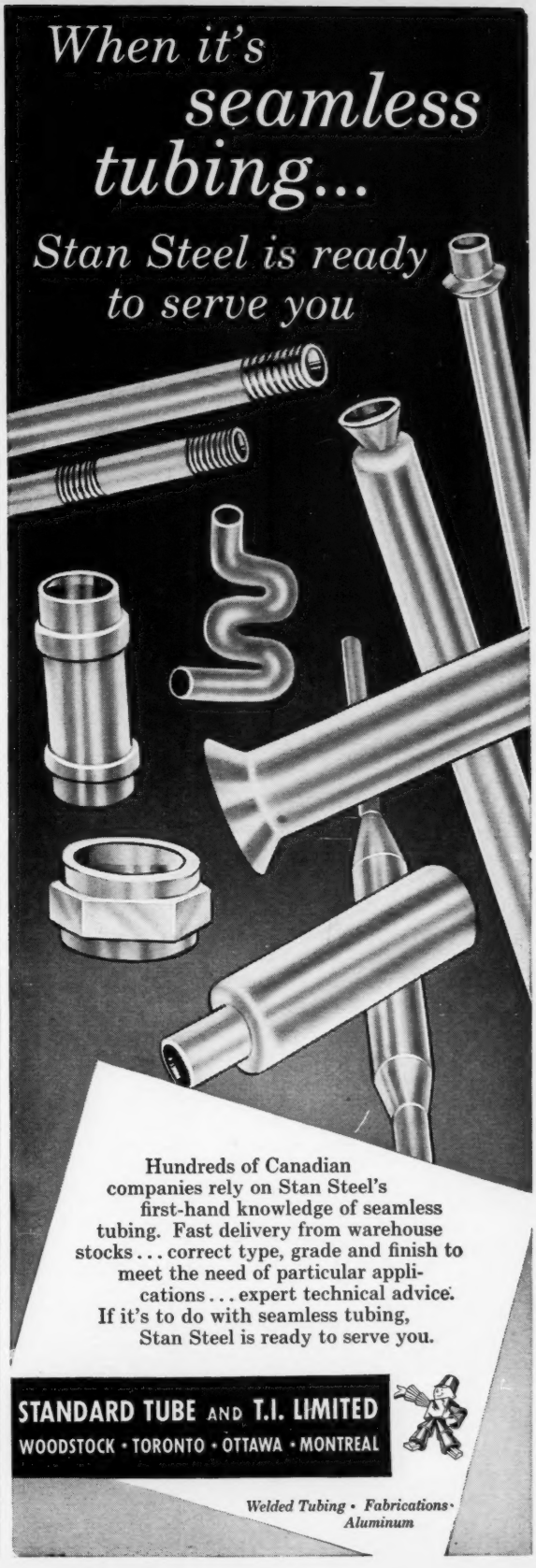
The die was mounted in a 135-ton Minster punch press and the blanks of BQ8A3X steel (which were stacked flame-cut to shape, cleaned and roto finished) were formed. Some 2,100 parts were produced satisfactorily. Any small variations that were found were well within the required tolerance and were due to differences in the flame-cut blanks. Parts No. 1 and No. 2,100 were practically identical. The blank and these two parts are shown in Fig. 2.

The experience gained in producing this successful forming die will enable CGE to produce other plastic tools for various operations. Future tools of this type will have the silicon carbide mix cast first, semi cured and then the rest of the resin poured and the two cured at the same time. This method would prevent the flaking off of the hard surface.

The cracking that took place (it is felt) could have been prevented if the die had been mounted in the press on a suitable back plate.

The savings realized by producing a die of this type (rather than a conventional one) are about $500. The minimum manufacturing savings gained by using this die are estimated at $200.

The experimental run has established that, for some types of operation, the previous limit of 16 gauge steel can be exceeded when these methods are used. ★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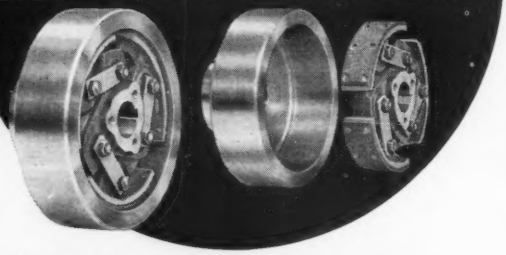

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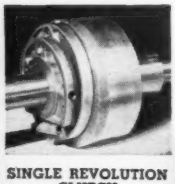

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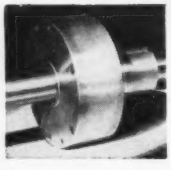

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(Continued from page 80)

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Answers to KWIZ KORNER

(Questions are on page 79)

1(a). **Redundant frame.** Consider a plane pin-jointed frame with "n" joints. For rigidity, there must then be (2n—3) members, whereupon the frame is said to be perfect or just-stiff. Any additional member has the effect of making the frame redundant.

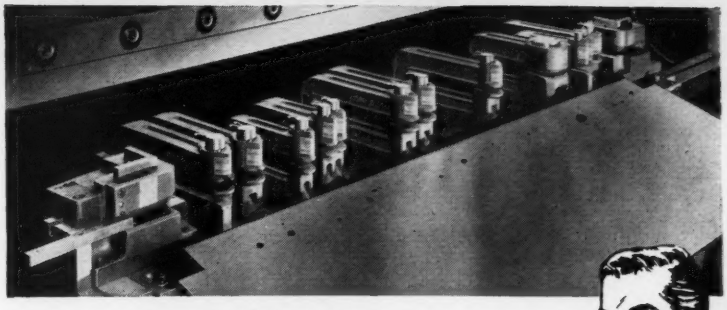
1(b). **Portal frame.** Basically a U (or inverted U) type structure, it can consist of two vertical members pinned or fixed at one end and rigidly attached to cross bracing at the other.

2(a). **Mach number.** When used in connection with high-speed flight, the Mach number (M) is the ratio of the speed of the aircraft to the speed of sound.
The name is used in honor of the Austrian physicist, Enrst Mach, who developed the basic theory of shock waves.

2(b). **Octane number.** A convenient way of indicating the knock rating of gasoline is by means of its octane number. This is the percentage of iso-octane which (on test) has the same antidetonation effect as the gasoline.

3(a). **Spot face.** The flat surface machined locally on a component to accommodate a bolt head.

3(b). **Spot weld.** Type of weld obtained by passing an electric current through two electrodes in contact with the parts to be joined. Heat is generated which melts the metal locally and welds the parts together.



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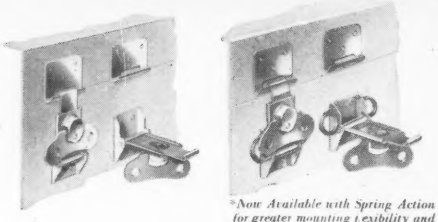

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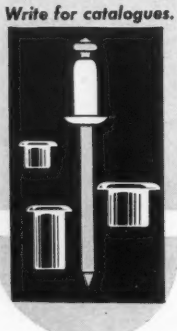

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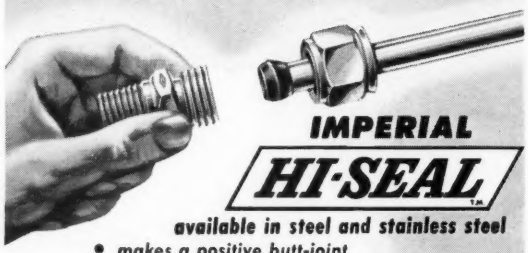

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Editorial

Design Engineering questionnaire

As readers are well aware, a questionnaire was recently sent out by DESIGN ENGINEERING with the object of getting a cross-sectional view of reader opinion.

The number of replies received was most gratifying and there seems to be no doubt that basically DESIGN ENGINEERING (as at present constituted) is catering well for its readers.

Of the many helpful remarks received, one suggestion is that we give more information about new products. This, as it happens, we were just about to do as the questionnaire went out, as witness the Ideas Round-up feature that started with the December issue.

Quite a number of readers request more technical articles (that is, articles of a more technical nature) but we don't think that this is necessarily a good thing. Engineers who are in, say, some branch of mechanical engineering, can get all the specialized information they require in that particular field from the literature of their own technical society. If they want to get a broad view of engineering, however, it is not so easy and we feel that one of the functions of DESIGN ENGINEERING is to keep the reader abreast of the times in branches of design engineering other than his own.

A high percentage think that a product design handbook would be a good idea and we are, therefore, contemplating a special issue this year on these lines to bring together, between the covers of one magazine, details of materials, products and finishes most likely to help the design engineer.

One humorist suggests that we use better English. Perhaps he would like us to follow Beachcomber's advice: do not finish a sentence with a preposition unless you have nothing else to finish it with.

Quite seriously though, the replies to the questionnaire have been of great help to the staff of DESIGN ENGINEERING and when we have had an opportunity of studying them in more detail we shall most certainly pass on our findings.

In the meantime may we take this opportunity of thanking all those who took the trouble to let us know their opinions. It will all help to make DESIGN ENGINEERING a better book for you in 1957 and the ensuing years.

William Morse.

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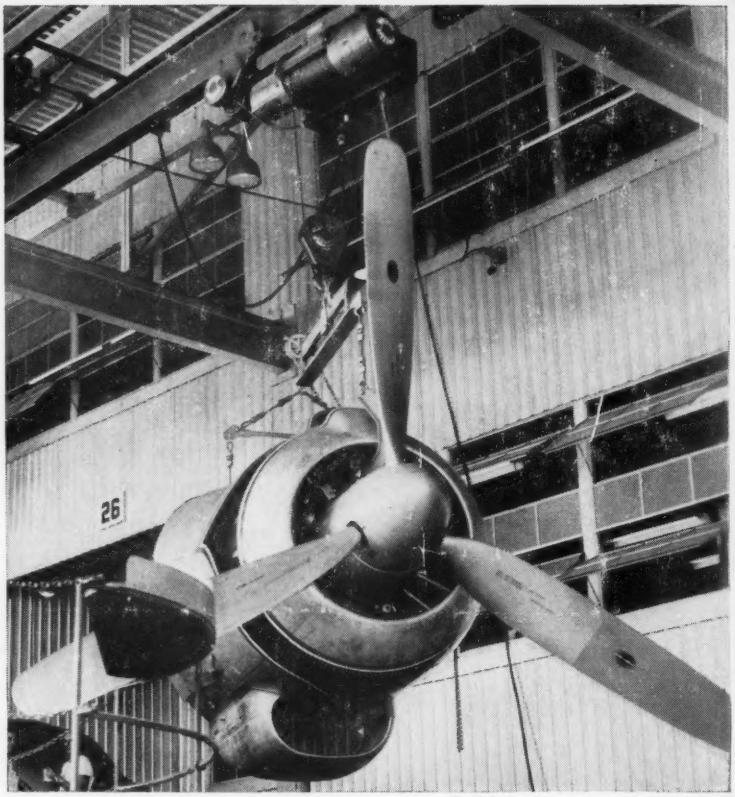

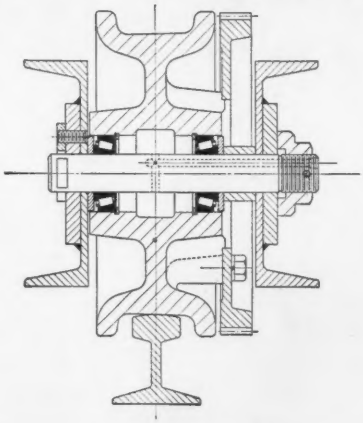

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